

UNIVERSITY OF DERBY

THE EFFECTS OF ANXIETY ON VISUAL
ATTENTION FOR EMOTIVE STIMULI IN
PRIMARY SCHOOL CHILDREN

Lauren Kelly

Doctor of Philosophy

2013

List of Contents

Chapter 1 – Theoretical Overview

1.1 Introduction	1
1.2 Anxiety	1
1.2.1 Anxiety as an Adaptive Function	1
1.2.2 Anxiety as a Maladaptive Function	3
1.2.3 Anxiety in Children	4
1.2.4 Risk Factors for Anxiety	6
1.3 Attentional Bias for Threat in Anxiety	6
1.3.1 Aspects of Attention	6
1.3.2 Attentional Bias	7
1.3.3 Theoretical Models of Attentional Bias in Anxiety	8
1.3.3.1 <i>Facilitated Engagement</i>	8
1.3.3.2 <i>Facilitated Engagement and Impaired Disengagement</i>	10
1.3.3.3 <i>Facilitated Engagement and Avoidance</i>	10
1.3.3.4 <i>Summary</i>	12
1.4 Application of Theoretical Models to the Development of Attentional Bias in Childhood Anxiety	13
1.5 Thesis Aims and Objectives	15

Chapter 2 – Methodology and Research Overview

2.1 Introduction	17
2.2 Cognitive Techniques Investigating Temporal Attention	17
2.2.1 Rapid Serial Visual Presentation with the Attentional Blink	17
2.3 Cognitive Techniques Investigating Spatial Attention	19
2.3.1 Visual Search	19
2.3.2 Spatial Cueing	20
2.3.3 Visual Probe	21
2.3.4 Visual Probe with Eye Tracking	22
2.4 Anxiety and Temporal Attentional Bias Research	22
2.4.1 Facilitated Engagement	22

2.4.2 Impaired Disengagement	23
2.5 Anxiety and Spatial Attentional Bias Research	23
2.5.1 Facilitated Engagement	23
2.5.2 Impaired Disengagement	24
2.5.3 Avoidance	25
2.6 Stimulus Type	26
2.7 Summary	27

Chapter 3 – Investigations One and Two: The Non-Emotive and the Emotive Attentional Blink Task

3.1 Introduction	28
3.2 Investigation One: The Non-Emotive Attentional Blink Task (A Control Study)	35
3.2.1 Methods	35
3.2.1.1 Participants	35
3.2.1.2 Stimuli	35
3.2.1.3 Questionnaire Measures	36
3.2.1.3.1 <i>Anxiety</i>	36
3.2.1.3.2 <i>Dysphoria</i>	37
3.2.1.4 General Procedure	38
3.2.1.5 Attentional Blink Task Procedure	38
3.2.1.6 Data Analysis	41
3.2.2 Results	42
3.2.2.1 Attentional Blink Analysis	42
3.2.2.2 Effects of Age	43
3.2.2.3 Trait Anxiety Analysis	43
3.2.2.4 State Anxiety Analysis	43
3.2.3 Discussion	43
3.3 Investigation Two: Facilitated Engagement towards Emotive Stimuli during the Attentional Blink Task	45
3.3.1 Methods	45
3.3.1.1 Participants	45
3.3.1.2 Stimuli	46

3.3.1.3 General Procedure	47
3.3.1.4 Attentional Blink Task Procedure	47
3.3.1.5 Data Analysis	50
3.3.2 Results	50
3.3.2.1 Attentional Blink Analysis	50
3.3.2.2 Trait Anxiety Analysis	52
3.3.2.3 State Anxiety Analysis	53
3.3.2.4 Task Difficulty	54
3.3.2.5 Effects of Age	54
3.3.3 Discussion	55

Chapter 4 – Investigation Three: Facilitated Engagement towards Emotive Stimuli during a Simplified Version of the Attentional Blink Task

4.1 Introduction	57
4.2 Methods	59
4.2.1 Pre-selection	59
4.2.2 Final Participants	60
4.2.3 Stimuli	60
4.2.4 Procedure	60
4.2.5 Data Analysis	61
4.3 Results	61
4.3.1 Attentional Blink Analysis	61
4.3.2 Trait Anxiety Analysis	64
4.3.3 State Anxiety Analysis	66
4.3.4 Effects of Age	66
4.4 Discussion	66

Chapter 5 – Investigation Four: Disengagement from Emotive Stimuli during the Attentional Blink Task

5.1 Introduction	72
5.2 Methods	76
5.2.1 Pre-selection	76

5.2.2 Final Participants	76
5.2.3 Stimuli	77
5.2.4 General Procedure	77
5.2.5 Attentional Blink Task Procedure	77
5.2.6 Data Analysis	80
5.3 Results	80
5.3.1 Attentional Blink Analysis	80
5.3.2 Trait Anxiety Analysis	83
5.3.3 State Anxiety Analysis	84
5.4 Discussion	85

Chapter 6 – Investigation Five: Covert Attentional Bias for Emotive Stimuli during the Visual Probe Task

6.1 Introduction	89
6.2 Methods	94
6.2.1 Pre-selection	94
6.2.2 Final Participants	94
6.2.3 Stimuli	94
6.2.4 Self-Report Measures	97
6.2.4.1 <i>Attentional Control</i>	97
6.2.5 General Procedure	98
6.2.6 Administration of Self-Report Measures	99
6.2.7 Visual Probe Task	99
6.2.8 Subjective Appraisal Task	102
6.2.9 Data Preparation	104
6.2.10 Data Analysis	105
6.3 Results	106
6.3.1 Trait Anxiety Analysis	106
6.3.1.1 <i>Reaction Time Data</i>	106
6.3.1.2 <i>Attentional Bias Scores</i>	107
6.3.1.3 <i>Components of Attentional Bias</i>	109
6.3.1.4 <i>Attentional Control and Trait Anxiety</i>	109
6.3.2 State Anxiety Analysis	110

6.3.2.1 <i>Reaction Time Data</i>	110
6.3.2.2 <i>Attentional Control and State Anxiety</i>	111
6.3.3 Subjective Appraisal and Trait Anxiety	111
6.3.3.1 <i>Arousal Analysis</i>	111
6.3.3.2 <i>Valence Analysis</i>	113
6.3.4 Subjective Appraisal and State Anxiety	114
6.3.4.1 <i>Arousal Analysis</i>	114
6.3.4.2 <i>Valence Analysis</i>	115
6.4 Discussion	116

Chapter 7 – Investigation Six: The Time Course of Overt Attentional Bias for Emotive Stimuli during the Visual Probe Task

7.1 Introduction	121
7.2 Methods	127
7.2.1 Pre-selection	127
7.2.2 Final Participants	127
7.2.3 Stimuli	128
7.2.4 Self-Report Measures	128
7.2.5 General Procedure	128
7.2.6 Administration of Self-Report Measures	129
7.2.7 Visual Probe Task	129
7.2.8 Eye Tracking	130
7.2.9 Subjective Appraisal Task	134
7.2.10 Behavioural Data Preparation	134
7.2.11 Behavioural Data Analysis	135
7.2.12 Eye Tracking Data Preparation	135
7.2.13 Eye Tracking Data Analysis	136
7.3 Results	137
7.3.1 500ms Visual Probe Results	137
7.3.1.1 Trait Anxiety Analysis	137
7.3.1.1.1 <i>Reaction Time Data</i>	137
7.3.1.2 State Anxiety Analysis	138
7.3.1.2.1 <i>Reaction Time Data</i>	138

7.3.2 2000 ms Visual Probe Results	138
7.3.2.1 Trait Anxiety Analysis	138
7.3.2.1.1 <i>Reaction Time Data</i>	138
7.3.2.1.2 <i>Attentional Bias Scores</i>	139
7.3.2.1.3 <i>Components of Attentional Bias</i>	141
7.3.2.2 State Anxiety Analysis	142
7.3.2.2.1 <i>Reaction Time Data</i>	142
7.3.2.3 Attentional Control and Trait Anxiety	142
7.3.2.4 Attentional Control and State Anxiety	142
7.3.2.5 Subjective Appraisal and Trait Anxiety	143
7.3.2.5.1 <i>Arousal Analysis</i>	143
7.3.2.5.2 <i>Valence Analysis</i>	144
7.3.2.6 Subjective Appraisal and State Anxiety	145
7.3.2.6.1 <i>Arousal Analysis</i>	145
7.3.2.6.2 <i>Valence Analysis</i>	146
7.3.3 Eye Tracking Results	146
7.3.3.1 Trait Anxiety Analysis	146
7.3.3.1.1 <i>Biases in Initial Orienting to Stimuli Presented for 500 ms</i>	146
7.3.3.1.2 <i>Biases in Initial Orienting to Stimuli Presented for 2000 ms</i>	146
7.3.3.1.3 <i>Biases in Sustained Attention of Stimuli Presented for 2000 ms</i>	147
7.3.3.2 State Anxiety Analysis	147
7.3.3.2.1 <i>Biases in Initial Orienting to Stimuli Presented for 500 ms</i>	147
7.3.3.2.2 <i>Biases in Initial Orienting to Stimuli Presented for 2000 ms</i>	148
7.3.3.2.3 <i>Biases in Sustained Attention of Stimuli Presented for 2000 ms</i>	148
7.4 Discussion	149
7.4.1 Behavioural Data	150
7.4.2 Eye Tracking Data	152

Chapter 8 – General Discussion

8.1 Introduction	156
8.2 Thesis Overview	156
8.3 Summary of Main Findings	159
8.4 Implications	161

8.4.1 Past Research and Theoretical Models	161
8.4.2 Clinical Practice	163
8.5 Limitations and Future Directions	166
8.6 Conclusions	167

References	169
-------------------	-----

Appendices

Appendix A The State-Trait Anxiety Inventory for Children (STAI-C)	i
Appendix B The Short Version of the Children's Depression Inventory (CDI-S)	iii
Appendix C Example covering letters, brief/debrief, and consent form	iv
Appendix D Modified NimStim Face Set used in Investigations Five to Seven	x
Appendix E The Attentional Control Scale for Children (ASC-C)	xiii

List of Figures

Chapter 1 – Theoretical Overview

Figure 1.1 A diagram demonstrating the evolutionary perspective of anxiety	3
---	---

Chapter 3 – Investigations One and Two: The Non-Emotive and the Emotive Attentional Blink Task

Figure 3.1 The shape stimuli utilised: a square, triangle and circle	36
Figure 3.2 Examples of the distracter stimuli utilised	36
Figure 3.3 Example of a double-target trial in which the T1 was a square and the T2 was a triangle	40
Figure 3.4 The mean percentage of correct responses for each lag	42
Figure 3.5 The schematic facial stimuli utilised displaying angry, positive and neutral (N1 and N2, respectively) facial expressions	46
Figure 3.6 Examples of the distracter stimuli utilised	47
Figure 3.7 Example of a double-target trial in which the T1 was a neutral face and the T2 was an angry face	49
Figure 3.8 The mean percentage of correct responses for each lag	52
Figure 3.9 The mean percentage of correct responses for each valence	52

Chapter 4 – Investigation Three: Facilitated Engagement towards Emotive Stimuli during a Simplified Version of the Attentional Blink Task

Figure 4.1 Examples of the distracter stimuli utilised	60
Figure 4.2 The mean percentage of correct responses for each lag	63
Figure 4.3 The mean percentage of correct responses for each valence	63
Figure 4.4 The effects of trait anxiety and valence on the percentage of correct responses	65

Chapter 5 – Investigation Four: Disengagement from Emotive Stimuli during the Attentional Blink Task

Figure 5.1 Example of a double target trial in which the T1 was an angry face and	79
--	----

the T2 was a neutral face

Figure 5.2 The mean percentage of correct responses for each lag	82
Figure 5.3 The mean percentage of correct responses for each valence	82
Figure 5.4 The effects of valence and lag on the percentage of correct responses	83

Chapter 6 – Investigation Five: Covert Attentional Bias for Emotive Stimuli during the Visual Probe Task

Figure 6.1 Example of an angry, happy and neutral facial expression from the NimStim face stimulus set (actor 3; Tottenham et al., 2009)	96
Figure 6.2 Example of a modified angry, happy and neutral facial expression from the NimStim face stimulus set (actor 3; Tottenham et al., 2009)	96
Figure 6.3 The visual probe task procedure	101
Figure 6.4 Example of a trial in the arousal visual analogue scale	103
Figure 6.5 Example of a trial in the valence visual analogue scale	104
Figure 6.6 Example of how the attentional bias scores were calculated	106
Figure 6.7 Attentional bias scores as a function of trait anxiety and valence	109
Figure 6.8 The effect of face type on mean arousal ratings	112
Figure 6.9 The effects of trait anxiety and face type on the mean valence ratings	114
Figure 6.10 The effects of state anxiety and face type on the mean valence ratings	116

Chapter 7 – Investigation Six: Eye Movements and the Time Course of Overt Attentional Bias for Emotive Stimuli during the Visual Probe Task

Figure 7.1 The CRS 50 Hz infrared eye tracker	132
Figure 7.2 Diagram demonstrating communication between hardware and software during eye tracking	132
Figure 7.3 The eye tracker camera window displaying a centrally positioned eye (experimenter's view)	133
Figure 7.4 Calibration window with default settings (experimenter's view)	133
Figure 7.5 Attentional bias scores as a function of trait anxiety and valence	141
Figure 7.6 The effect of face type on mean subjective arousal ratings	144
Figure 7.7 The effect of face type on mean subjective valence ratings	145

List of Tables

Chapter 1 – Theoretical Overview

Table 1.1 Anxiety Disorders and Their Definitions (American Psychiatric Association, 2013)	4
Table 1.2 Summary of the Theoretical Models of Attentional Bias and Anxiety with Regards to Their Predictions of Attentional Bias Components, Attention Domains and Relevance to Child Populations	13

Chapter 3 – Investigations One and Two: The Non-Emotive and the Emotive Attentional Blink Task

Table 3.1 Mean Percentage of Correct Responses as a Function of Lag and Valence	51
--	----

Chapter 4 – Investigation Three: Facilitated Engagement towards Emotive Stimuli during a Simplified Version of the Attentional Blink Task

Table 4.1 Mean Percentage of Correct Responses as a Function of Lag and Valence	62
Table 4.2 Mean Percentage of Correct Responses as a Function of Lag and Valence for High and Low Trait Anxious Participants	64

Chapter 5 – Investigation Four: Disengagement from Emotive Stimuli during the Attentional Blink Task

Table 5.1 Mean Percentage of Correct Responses as a Function of Lag and Valence	81
Table 5.2 Mean Percentage of Correct Responses as a Function of Lag and Valence for High and Low Trait Anxious Participants	83

Chapter 6 – Investigation Five: Covert Attentional Bias for Emotive Stimuli during the Visual Probe Task

Table 6.1 Disentangling the Specific Components of Attentional Bias	92
--	----

Table 6.2 Gender, Ethnicity, Reliability and Validity Scores for all Actors and Facial Expressions Utilised in the Current Research (Tottenham et al., 2009)	95
Table 6.3 Original and Revised Items from the Attentional Control Scale for Children (ACS-C; Muris et al., 2004)	98
Table 6.4 Critical Trial Types in the Visual Probe Task	100
Table 6.5 Mean Reaction Times to Probes as a Function of Trait Anxiety, Valence and Congruency	107
Table 6.6 Mean Attentional Bias Scores as a Function of Trait Anxiety and Valence	107
Table 6.7 Frequency of Participants as a Function of Trait Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)	110
Table 6.8 Frequency of Participants as a Function of State Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)	111
Table 6.9 Mean Arousal Ratings as a Function of Trait Anxiety and Face Type	112
Table 6.10 Mean Percentage of Valence Ratings as a Function of Trait Anxiety and Face Type	113
Table 6.11 Mean Arousal Ratings as a Function of State Anxiety and Face Type	114
Table 6.12 Mean Percentage of Valence Ratings as a Function of State Anxiety and Face Type	115

Chapter 7 – Investigation Six: Eye Movements and the Time Course of Overt Attentional Bias for Emotive Stimuli during the Visual Probe Task

Table 7.1 Mean Reaction Times to Probes as a Function of Trait Anxiety, Valence and Congruency	137
Table 7.2 Mean Reaction Times to Probes as a Function of Trait Anxiety, Valence and Congruency	139
Table 7.3 Mean Attentional Bias Scores as a Function of Trait Anxiety and Valence	139
Table 7.4 Frequency of Participants as a Function of Trait Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)	142
Table 7.5 Frequency of Participants as a Function of State Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)	143
Table 7.6 Mean Attentional Bias Scores as a Function of State Anxiety and	148

Valence for the 500 ms Condition

Chapter 8 – General Discussion

Table 8.1 Definitions of the Components of Attentional Bias

157

Abstract

Anxiety can be advantageous in terms of survival and well-being, yet atypically high levels may be maladaptive and result in the clinical diagnosis of an anxiety disorder. Several risk factors have been implicated in the manifestation of clinical anxiety, including cognitive biases. In recent years, a plethora of research has emerged demonstrating that anxious adults exhibit biases of attention for threatening stimuli, especially that which is biologically relevant (e.g., facial expressions). Specific components of attentional bias have also been identified, namely facilitated engagement, impaired disengagement, and avoidance. However, the majority of studies have focused on the spatial domain of attention. Furthermore, the area is under-researched in children, despite research demonstrating that symptoms relating to clinical and non-clinical anxiety follow a stable course from childhood through to adolescence and adulthood. Consequently, the aim of this thesis was to investigate how anxiety affects children's visual attention for emotive, particularly angry, faces. In order to provide a more comprehensive understanding, the current research involved examining the role of temporal and spatial attention utilising rapid serial visual presentation with the attentional blink, and the visual probe paradigm, respectively. The main hypothesis was that high state and/or trait anxiety would be associated with an attentional bias for angry, relative to positive or neutral faces in both the temporal and spatial domains.

In relation to the temporal domain, key findings demonstrated that high levels of trait anxiety were associated with facilitated engagement towards both angry and neutral faces. It was further found that all children rapidly disengaged attention away from angry faces. Findings related to the processing of angry faces accorded with the main hypothesis stated in this thesis, as well as research and theory in the area. The finding that anxious children preferentially processed neutral faces in an attentional blink investigation was unexpected. This was argued to potentially reflect this stimulus type being interpreted as threatening. Key findings regarding the spatial domain were that high trait anxious children displayed an early covert bias of attention away from happy faces and a later, overt bias of attention away from angry faces. The finding that high trait anxiety was linked to an attentional bias away from happy faces in a visual probe task was also unexpected. This was argued to potentially reflect smiling faces being interpreted as signifying social dominance, thus resulting in the viewer experiencing feelings of subordination and becoming avoidant and/or submissive. To conclude, this thesis has enhanced current knowledge of attentional bias in both the temporal

and spatial domains for emotive stimuli in anxious children. It has demonstrated that higher levels of trait anxiety moderate children's allocation of attentional resources to different stimulus types, whether these are threatening, positive, or neutral. This has important implications for evaluating past research in adults and children, and for further developing theoretical models of attentional bias and anxiety. It also offers important clinical implications, since attending towards or away from specific stimuli may affect the development and maintenance of anxiety disorders. Recently, a treatment that aims to modify attentional bias in anxious individuals has begun to be developed. In light of the present findings, it may be necessary to review this treatment so that anxious children are re-trained in the specific biases of attention demonstrated here.

Acknowledgements

Firstly, I would like to express my utmost appreciation to Frankie Maratos and Sigrid Lipka, who have supervised my PhD and provided attentive feedback. I would also like to acknowledge Steve Croker, who was there to offer support during the initial stages of my PhD. I am thankful to the members of staff at the various schools that I collected data from. I am also extremely grateful to all the children who took part in my research, and to those parents/guardians who went to the trouble of bringing their children into the University for one of the studies. My time at the University of Derby has been made more enjoyable thanks to my fellow postgraduates, particularly Atiya and Mike. Last but certainly not least, I would like to thank my friends and family for being there to encourage me and offer support throughout, especially Alex and my parents.

CHAPTER 1

Theoretical Overview

1.1 Introduction

The focus of this thesis is on anxiety and visual attentional bias for emotive stimuli in children. This chapter will begin by providing an overview of anxiety, both as an evolutionary adaptive function and as a disorder, with an emphasis placed on children. The risk factors for anxiety will then be outlined, highlighting the importance of cognitive processes, particularly biases of attention. This will then be followed by an overview of the most prominent related theoretical models. It will be highlighted that these models do not explicitly account for developmental aspects of attentional bias for threat in anxiety. Reasons for, and implications of, conducting further research with children in the present thesis will then be discussed. This chapter will end by outlining the aims and objectives of the current PhD research.

1.2 Anxiety

1.2.1 Anxiety as an Adaptive Function

Anxiety has been defined as a complex state of psychological distress that manifests as a result of cognitive, affective, physiological, and behavioural responses to threatening objects or situations (Barlow, 2002). Psychologists typically categorise anxiety into two separate forms: worry and fear (Weems & Watts, 2005). Worry is mainly a cognitive response to threat, in which an individual considers and prepares for possible future danger. It also includes affective responding, which appears to be subjective but has been described as persistent psychological distress that may result in apprehension or tension (Weis, 2008). In contrast, fear is instigated by immediate threat, which tends to result in physiological and behavioural reactions. The physiological responses that take place include increased blood flow towards the brain and muscles, additional epinephrine (i.e., adrenaline) production, accelerated heart rate, vasoconstriction, and increased breathing rate (Weis, 2008). These changes to the body are controlled by an intricate network of fibres, namely the autonomic nervous system (ANS), which directs signals to various muscles, glands and organs. The

purpose of the ANS is to regulate the functioning of the body's internal environment. It is assumed that the physiological reactions caused by the ANS prepare the body for responding to the immediate threat either through confrontation or escape, which are also referred to as 'fight or flight' (Fox, 2008).

According to many researchers, anxiety has developed as a result of biological evolution, since it provided solutions to problems that our ancestors experienced (e.g., Ekman, 1992; Öhman & Birbaumer, 1993; Tomkins, 1984; Tooby & Cosmides, 1990, 2000). One of these problems would have been avoiding danger, which may have included life threatening events. Overcoming this problem would have enabled our ancestors to continue the gene pool and thus, anxiety has been selected by nature to ensure that this process continues. A fundamental assumption relating to anxiety is that the cognitive, affective, physiological and behavioural responses described earlier can be elicited by stimuli that are biologically relevant. Evidence for this has been demonstrated in both animals and humans. For example, Panksepp (1998) found that rats responded to the odour of a cat with a classic fear response, despite having been raised under laboratory conditions with no prior exposure to such animals. Therefore, it would appear that rats have an innate fear of cats or at least, the smell, of cats. Furthermore, the most common fears and phobias experienced by humans are likely to have threatened the survival of our ancestors, such as dangerous animals (e.g., spiders, snakes), heights, and enclosed spaces. This is in contrast to frequently encountered but potentially deadly objects in modern life, such as cars, guns, knives etc. (Öhman & Mineka, 2001; Seligman, 1971). This evidence suggests that evolution has resulted in the acquisition of fairly automatic responses to stimuli that are likely to be dangerous (or advantageous), even during the present day [*see Figure 1.1 for a diagram of the evolutionary perspective*]. Although anxiety is thought to be part of a core set of emotions that are biologically programmed, most researchers believe that it can be altered through learning, and its expression formed by culture (e.g., Ekman, 1999).

For most individuals, anxiety still serves as a beneficial function that facilitates the rapid coordination of responses that allow for coping with future or immediate threats to survival or wellbeing. One example of this in the present day is that moderate levels of fear during confrontation with a potential attacker may help to maintain an individual's safety or even their survival. Similarly, reasonable levels of worry before an exam can help motivate an individual to revise. Although moderate anxiety can be effective, some individuals experience atypically high levels of fear and/or worry, which may be maladaptive and lead to

the clinical diagnosis of an anxiety disorder. The next section of this chapter will include an overview of clinical anxiety and the different forms that are proposed to exist.

[Content removed for copyright reasons]

Figure 1.1 A diagram demonstrating the evolutionary perspective of anxiety. Adapted from *Emotion Science: Neuroscientific and Cognitive Approaches to Understanding Human Emotions* (p. 5), by E. Fox, 2008, Palgrave Macmillan. Copyright 2008 by Elaine Fox.

1.2.2 Anxiety as a Maladaptive Function

Unlike typically functioning anxiety, clinical anxiety has a tendency to be constant, unreasonably intense (i.e., out of proportion to the threat), and to interfere with an individual's psychosocial or physiological functioning (e.g., Lader & Marks, 1973). According to the Diagnostic and Statistical Manual of Mental Disorders (*DSM-V*; American Psychiatric Association [APA], 2013), there exist several different forms of anxiety disorder: generalised anxiety disorder (GAD); panic disorder (typically co-morbid with agoraphobia); specific phobia, social anxiety disorder; and separation anxiety [*see Table 1.1 for basic definitions*]. Based on the 2001 Census and findings from a recent household survey, it appears that the prevalence of anxiety disorders in England for adults is approximately 8%, which accounts for nearly half of all adult mental illness (McManus, Meltzer, Brugha, Bebbington, & Jenkins, 2009). This statistic is of concern since it has been estimated that half of the population will have a diagnosable mental illness at some stage in their life (Kessler, Berglund, Demler, Jin, & Walters, 2005). Another important fact is that anxiety disorders often co-occur with depression (e.g., Hirschfeld, 2001; Mineka, Watson, & Clark, 1998). In fact, mixed anxiety and depression is thought to be the most common mental illness in the United Kingdom, with almost 9% of people meeting the diagnosis criteria (Singleton,

Bumpstead, O'Brien, Lee, & Meltzer, 2001). Anxiety and depression are similar in that they both feature high levels of negative affect and distress, however, depression also presents unique features such as thoughts of failure or worthlessness (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoor, 2007).

Table 1.1

Anxiety Disorders and Their Definitions (American Psychiatric Association, 2013)

Anxiety disorder	Definition
Generalised anxiety disorder	Ongoing excessive tension and worry about the future (i.e., apprehensive expectation).
Panic disorder (often with agoraphobia)	Recurrent panic attacks (i.e., short episodes of panic that occur unexpectedly). Often leads to avoidance/endurance with anxiety of situations from which escape might be difficult / help might be unavailable in the event of a panic attack.
Separation anxiety	Inappropriate and excessive anxiety related to separation from home or from those to whom the individual is emotionally attached.
Social anxiety disorder	Excessive and persistent fear of social or performance situations in which embarrassment might occur.
Specific phobia	Excessive and persistent fear of specific objects or situations.

1.2.3 Anxiety in Children

Past research has demonstrated that non-clinical levels of anxiety appear in early childhood and follow a typical developmental course (Hadwin & Field, 2010). According to Kagan, Kearsley, and Zelazo (1978), children younger than two years old display temporary fear and worry related to separation and strangers. From the ages of two to five years, children show that they are afraid of naturally occurring events, such as darkness, death, fire and thunderstorms (Beesdo, Knappe, & Pine, 2011). As children reach the age of approximately five or six years old, they begin to display fears related to imaginary objects

(e.g., ghosts, monsters; Bauer, 1976). This is thought to be a result of cognitive change related to an emerging imaginative capacity (Wellman, 1990). In later years, children have been found to experience more complex cognitive worries, such as that of failure (Muris, Merckelbach, Gadet, & Moulaert, 2000; Schaefer, Watkins, & Burnham, 2003). It is said that these worries are linked to characteristic features of a child's environment (Stevenson, Batten, & Cherner, 1992). For example, a worry about failure may emerge in later primary school years because higher academic expectations are placed on a child.

In regards to clinical anxiety, it has been found that symptoms of the disorder exist in children as young as three years (Egger & Angold, 2006). According to the DSM-V (American Psychiatric Association, 2013), children may be diagnosed with any of the anxiety disorders previously mentioned. It has been determined that the prevalence of anxiety in England is 3.3% for children aged five to sixteen years, which accounts for a third of all child mental illness (Green, McGinnity, Meltzer, Ford, & Goodman, 2005). The development of anxiety disorders follows a similar pattern to the development of non-clinical anxiety, such that specific disorders have been found to occur at different stages of development (Weems, 2008). Separation anxiety is most commonly diagnosed in early childhood, generalised anxiety disorder can occur around the ages of four to five years, and social anxiety disorder and specific phobias are not typically diagnosed until children reach the age of approximately six years (Beesdo et al., 2011). It has been argued that this is because children first have to undergo cognitive, emotional and physical growth (Bengtsson, 2005; Selman, 1980).

Since anxiety disorders follow a developmental course, they are said to be less clear cut in children than in adults (Muris, 2007). Thus, it may be more appropriate to investigate the effects of anxiety in children utilising measures of trait anxiety. According to Spielberger (1972), trait anxiety is a relatively stable personality trait that predisposes an individual to respond with anxiety (i.e., apprehension/tension and increased activity of the ANS) to threatening objects or situations. Given that trait anxiety, relative to a specific anxiety disorder (e.g., spider phobia), refers to anxious mood in general, investigating this characteristic offers wider value to the study of anxiety as a whole. In addition, it has been claimed that trait anxiety is an important predisposition for the development of clinical anxiety (Barlow, 2002). When measuring levels of trait anxiety, it is important to consider levels of state anxiety. Spielberger (1972) described this as a temporary emotional state varying in intensity and fluctuating over time. It has been found that state and trait anxiety scores are positively correlated, possibly because high trait anxious individuals tend to

perceive more situations as threatening compared with those who have lower trait anxiety scores (Spielberger, 1972).

1.2.4 Risk Factors for Anxiety

Several risk factors have been implicated in the manifestation of anxiety. These include genetic make-up, stressful environmental events, temperament and personality, neurobiological processes, and cognitive processes. It is thought that a combination of these factors interact with each other to enhance an individual's vulnerability to becoming anxious. For example, a stressful life event (e.g., separation from a care giver) may modify the temperament of a child, leaving the child more prone to interpreting similar situations as negative, and hence more vulnerable to developing an anxiety disorder. When attempting to understand the causal factors of anxiety, it is important to focus on cognitive processes. This is because it has been established that the presence of distorted and irrational beliefs and thoughts (i.e., intrusive thoughts, negative automatic thoughts and worry) are key characteristics of anxiety (e.g., see Beck, Steer, Kovacs, & Garrison, 1985; Borkovec, Robinson, Pruzinsky, & Depree, 1983; and Rachman, 1981). Furthermore, a range of cognitive biases (i.e., attentional, interpretational, and memory) are regarded to play a fundamental role in the development of the disorder (e.g., see Cisler & Koster, 2010; Mathews & MacLeod, 2005; Ouimet, Gawronski, & Dozois, 2009 for reviews). In particular, recent years have seen a plethora of research indicating that anxiety is associated with biases of attention for threatening information (see Bar-Haim et al., 2007; Cisler & Koster, 2010; Yiend, 2010, for reviews). As Mathews (1990) has stated, "anxiety ... [is] associated with an automatic processing bias, initiated prior to awareness, but serving to attract attention to environmental threat cues, and thus facilitating the acquisition of threatening information" (p. 462).

1.3 Attentional Bias for Threat in Anxiety

1.3.1 Aspects of Attention

Attention refers to the process in which information is selected from the environment for enhanced processing. Over 100 years ago, the psychologist William James (1890), described attention as, "*the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought*", and suggested

that, *“It implies withdrawal from some things in order to deal effectively with others”* (pp. 403-404). Attention can be considered according to many aspects, such as whether it is **divided** between at least two stimulus inputs simultaneously or whether it is **focused** on one stimulus input whilst ignoring others. Attention can also be classified according to the **sensory modality** in which it occurs. These modalities include auditory, gustatory, olfactory, and tactile but the majority of research into attention has focused on the **visual** modality. This is because: i) vision is thought to be the most important sense modality; ii) it is possible to investigate a wider range of issues in visual attention; and iii) it is simpler to control precisely the presentation times of visual stimuli (Eysenck & Keane, 2005). In 1990, Posner and Peterson identified two networks of the visual attention system: i) **alerting**, which refers to a state of vigilance for information over time; and ii) **orienting**, which refers to the ability to select information from a particular location in the visual field (see also Fan, McCandliss, Sommer, Raz, & Posner, 2002; Fernandez-Duque & Posner, 1997; and Raz & Buhle, 2006). These networks cooperate to allow individuals to efficiently respond to environmental information in the **temporal** and **spatial** domains, respectively (Lu, Cai, Shen, Zhou, & Han, 2012).

1.3.2 Attentional Bias

Attentional bias refers to the preferential focusing of attention on a specific stimulus type, which can occur in either the spatial or temporal domain. Whilst biases of attention for threat have been consistently and robustly demonstrated in anxious adults, it is not certain how or why. However, a growing body of research has revealed that attentional bias for threat may consist of one or more of the following components: **facilitated engagement**, **impaired disengagement**, and/or **avoidance**. Facilitated engagement to threat refers to this stimulus type being selected and preferentially processed. Impaired disengagement from threat refers to difficulty in withdrawing attention (i.e., terminating selection and preferential processing) from a threatening stimulus, thus impairing attention switching. Finally, avoidance of threat refers to attention being allocated to locations other than the location of a threatening stimulus (e.g., Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004). It is thought that further investigation into these observable components will increase understanding of the mechanisms underlying attentional bias in anxiety (Cisler & Koster, 2010).

1.3.3 Theoretical Models of Attentional Bias and Anxiety

Over the last two decades, several models have been proposed in an attempt to explain attentional bias for threat in anxiety. Each theory assumes that the attentional bias effect plays a major role in the aetiology and maintenance of anxiety disorders. It is important to note that these models have mainly focused on levels of *trait* anxiety. Given the rationale for studying trait anxiety outlined in section 1.2.3, and that the magnitude of attentional bias is comparable across clinically anxious and high trait anxious individuals (Bar-Haim et al., 2007), it is reasonable to assume that the mechanisms proposed in the context of trait anxiety are also appropriate in understanding effects related to clinical anxiety (Cisler & Koster, 2010). In this section, the more prominent theoretical models of attentional bias and anxiety will be reviewed and presented according to the separate components of attentional bias. That is, models that simply propose facilitated engagement will be discussed first, followed by models that purport both facilitated engagement and impaired disengagement. Finally, models that propose both facilitated engagement and avoidance will be discussed.

1.3.3.1 Facilitated Engagement

Wells and Matthews (1994)

The model put forward by Wells and Matthews (1994) is distinctly different to any other. This is because it postulates that attention for threat is guided entirely by controlled (i.e., conscious), as opposed to automatic (i.e., unconscious), processes. According to the model, anxiety is the result of attentional bias, increased self-focused attention and activation of appraisal and self-beliefs. It is hypothesised that a *self-regulatory executive function* allows individuals to determine whether or not to attend to threat and this is based on acquired beliefs and/or knowledge. It is argued that anxiety is characterised by the belief that it is important to attend to threat and that this results in the attentional bias effect. An obvious limitation of this theory is that it cannot explain anxiety in early childhood since it relies on prior learning.

Mathews, Mackintosh, and Fulcher (1997); Mathews and Mackintosh (1998)

The ‘cognitive model’ proposed by Mathews et al. (1997), and Mathews and Mackintosh (1998) features a *threat evaluation system* (TES), which automatically appraises the threat level of competing stimuli and feeds the output into a *distracter/threat*

representation system (DTRS). Interference caused by the activation of the DTRS can be voluntarily totalled up to a certain level whilst attention is maintained on the competing stimuli and their representations strengthened. If the threat representation of a stimulus is interpreted as high then the DTRS inhibits the representation of less threatening stimuli, thus allowing threat to enter awareness. The interpretation of a stimulus depends on the perceived threat level of a stimulus based on the extent to which it matches previous representations stored in the TES. Attentional bias is caused by a heightened anxiety level, which increases output of the TES. This model further postulates that highly threatening stimuli will capture all individuals' attention, whereas weak threats will only do so in high anxious individuals. Although this model implies some innate ability to evaluate threat, it does not account for early childhood anxiety and attentional bias since it suggests that prior learning is required before either can occur. Another limitation of this model is that it suggests that attentional bias occurs only when there is competition amongst stimuli at a specific time point. Thus, this theory can only account for facilitated engagement in the spatial domain.

Öhman (1996; 2005)

The 'feature detection model' developed by Öhman (1996; 2005) suggests that attention to threat is an evolutionarily adaptive function and places particular emphasis on automatic processes. The model postulates that a *feature detection system* (FDS) enables biologically prepared stimuli to directly influence the arousal system and facilitate attentional allocation to threat. Once information has passed through the FDS, it is said to enter a *significance evaluation system* (SES). The SES allows for a slower, controlled appraisal of threatening or relevant information through interaction with the affective memories stored in the *expectancy system* (ES). If the information is appraised as threatening, the arousal system can again be influenced. Feedback loops between the arousal system and the SES mean that increased arousal further sensitises significance appraisal for specific stimuli. Prior learning, stored in the ES, can also sensitise significance appraisal for specific stimuli. An advantage of this theory over the previous two is that it implies an innate attentional bias for threat that is moderated depending on anxiety level. Thus, this model may well be able to explain facilitated engagement in childhood anxiety. However, it does not account for impaired disengagement from or avoidance of threat.

1.3.3.2 Facilitated Engagement and Impaired Disengagement

Beck and Clark (1997)

The ‘information processing model’ developed by Beck and Clark (1997) postulates that anxiety is characterised by biases that occur at three separate stages. The first stage comprises initial registration of a threatening stimulus through automatic orienting. On recognition of the salient stimulus, a primitive threat mode is activated in an attempt to ascertain safety and decrease threat level. This stage involves activation of innate cognitive, affective, physiological and behavioural responses. These responses are said to be inflexible and rigid because they have been developed to maintain survival [*see section 1.2.1 for further detail*]. During the second stage, attention is captured by threat and subsequent actions involve coping with threat. The final stage in the model involves elaboration of threatening information, which is effortful, detailed and schema-driven. As with Öhman’s (1996; 2005) theory, this model suggests that attentional bias for threat is biologically programmed and that it differs according to anxiety level. Thus, this model can likely explain both facilitated engagement and impaired disengagement in childhood anxiety (i.e., the final model component).

1.3.3.3 Facilitated Engagement and Avoidance

Williams, Watts, MacLeod, and Mathews (1988)

According to the model developed by Williams et al. (1988), an *affective decision mechanism* (ADM) evaluates the valence of stimulus input at an unconscious level. The ADM is moderated by state anxiety, such that increased levels of state anxiety result in higher appraisal of a threatening stimulus. This subsequently leads to activation of the *resource allocation mechanism* (RAM), which determines how attentional resources are allocated to the stimulus input. The RAM is moderated by trait anxiety in that higher levels of trait anxiety result in greater attentional resources being allocated to threat whereas lower levels of trait anxiety result in attentional resources being directed away from threat. Thus, this model proposes facilitated engagement to threat in high trait anxious individuals and avoidance in low trait anxiety. An advantage of this model is that it involves automatic processing, suggesting that prior learning is not a prerequisite for attentional bias. Thus, this theory is relevant to explaining attentional bias for threat in childhood anxiety. Furthermore, this

model provides support for both facilitated engagement and avoidance. Additionally, Yiend (2010) pointed out that the distinction between state and trait anxiety makes this theory strong in terms of its predictive and explanatory power. However, it has been argued that the explanation of threat processing in low trait anxiety is problematic (Mogg & Bradley, 1998) since it is improbable that severe threat will not draw attention, irrespective of anxiety levels (Cisler & Koster, 2010). Indeed, research has demonstrated that individuals with low trait anxiety display an attentional bias for severely but not moderately threatening stimuli (Wilson & MacLeod, 2003). Another limitation is that this model postulates that attentional bias occurs only when there is competition amongst stimuli or task demands. Thus, this theory may only account for spatial attention.

Mogg and Bradley (1998)

Mogg and Bradley's (1998) 'cognitive-motivational model' is strongly linked to neurobiological research, which demonstrates that it is possible to process threat through two distinct pathways: i) a quick route, allowing only rudimentary analysis of stimulus features; and ii) a slower route, allowing for more detailed analysis of stimulus features and contextual information, where top-down processing takes place (LeDoux, 1996). In accordance, the cognitive-motivational model specifies two structures to account for attention to threat: the *valence evaluation system* (VES) and the *goal engagement system* (GES). Like the ADM in Williams et al.'s (1988) model, the VES evaluates the threat value of stimulus input at an unconscious level. The reactivity of this structure to threat is moderated by trait anxiety, such that high trait anxiety results in increased sensitivity to threat. As well as threat level, output from the VES is moderated by contextual information, prior knowledge, and state anxiety. The GES is responsible for determining the allocation of attentional resources. If a high threat level is output from the VES, the GES interrupts current behaviour and directs attention towards the stimulus input. If a low threat level is output from the VES, current behaviour will not be interrupted and attention will remain on the task at hand.

According to this model, differences in attentional allocation to threat in high trait anxious and low trait anxious individuals can be expected for mild, but not severe, threat. This is because high trait anxiety is linked to an oversensitive VES, which results in the appraisal of ambiguous stimuli as threatening and this information being attended to. In contrast, this information will be appraised by low trait anxious individuals as non-threatening, resulting in the information being unattended to. An advantage of this theory is

that it implies an innate attentional bias for threat that is moderated depending on anxiety level. Thus, this model may be able to explain facilitated engagement and avoidance in childhood anxiety. However, it does not account for impaired disengagement from threat. Furthermore, as argued by Cisler and Koster (2010), there is little evidence for an oversensitive VES.

1.3.3.4 Summary

To recap, all models theorise that a component of attentional bias is facilitated engagement to threat. However, it is only Beck and Clark's (1997) theory that also accounts for impaired disengagement and only those models of Williams et al. (1988), and Mogg and Bradley (1998) that also account for avoidance. Furthermore, the theories put forward by Mathews and colleagues (Mathews et al., 1997; Mathews & Mackintosh, 1998) and Williams et al. (1988) are only able to explain components of spatial attentional bias. Thus, no model to date is able to fully explain *all* components of attentional bias for threat in anxiety. More importantly, none of the models *explicitly* account for developmental aspects of attentional bias for threat in anxiety. That said, it appears that some of the models (i.e., Öhman 1996, 2005; Beck & Clark, 1997; Mogg & Bradley, 1998; Williams et al., 1988) do imply that attentional bias is an innate phenomenon that is present during early childhood and moderated by anxiety level. A visual summary of the models in relation to their predictions of attentional bias components, attention domains and relevance to child populations is provided in Table 1.2. Given the theoretical discrepancies and lack of research investigating all components of attentional bias, it appears that further research is required to test these models, particularly in relation to children. Consequently, the present thesis aims to address this issue.

Table 1.2

Summary of the Theoretical Models of Attentional Bias and Anxiety with Regards to Their Predictions of Attentional Bias Components, Attention Domains and Relevance to Child Populations

	Facilitated Engagement	Impaired Disengagement	Avoidance	Spatial Attention	Temporal Attention	Children
Wells and Matthews (1994)	✓			✓	✓	
Mathews et al. (1997; 1998)	✓			✓		
Öhman (1996; 2005)	✓			✓	✓	✓
Beck and Clark (1997)	✓	✓		✓	✓	✓
Williams et al. (1988)	✓		✓	✓		✓
Mogg and Bradley (1998)	✓		✓	✓	✓	✓

1.4 Application of Theoretical Models to the Development of Attentional Bias in Childhood Anxiety

As highlighted in the previous section, the most prominent theoretical models of attentional bias and anxiety concern adults. That is, they merely imply that attentional bias is present during early childhood and moderated by anxiety. This is despite emerging evidence that attentional bias plays a causal role in the development of anxiety. Childhood-onset anxiety disorders are debilitating conditions, which pose significant risk factors for other affective and behavioural disorders (Lewinsohn, Holm-Denoma, Small, Seeley, & Joiner, 2008; Roza, Holstra, van der Ende, & Verhukst, 2003; Waters, Neumann, Henry, Craske, & Ornitz, 2008), such as adolescent and adult anxiety and depression (McGee, Feehan, Williams, & Anderson, 1992; Hayward, Killen, Kraemer, & Taylor, 2000), eating disorders and substance disorders (Merikangas, Avenevoli, Dierker, & Grillon, 1999). Childhood-onset anxiety is further linked to low academic performance (Asendorpf, Denissen, & van Aken, 2008; Kessler, Foster, Saunders, & Stang, 1995) and impaired social competence (Asendorpf

et al., 2008; Spence, Donovan, & Brechman-Toussaint, 1999). Research has demonstrated that symptoms relating to clinical and non-clinical anxiety follow a stable course from childhood (possibly earlier than two years of age; Kagan et al., 1978) through to adolescence and adulthood (Essau, Conradt, & Petermann, 2002; Roza et al., 2003; see Weems, 2008 for a review). Thus, if left to persist into adulthood, anxiety could result in a range of costly factors including unemployment, increased sick-leave, hospitalisation and treatment (Waghorn, Chant, White, & Whiteford, 2004).

Accordingly, researchers are increasingly acknowledging that it is of great importance to understand the factors that play a role in the aetiology and maintenance of anxiety over time. Early developmental models of anxiety did not recognise attentional bias as being causally linked (e.g., Muris & Merckelbach, 2001). However, a growing body of research has demonstrated that anxious children do display biases of attention for threat (e.g., Taghavi, Neshat-Doost, Moradi, Yule, & Dalglish, 1999; Vasey, Daleiden, Williams, & Brown, 1995; Vasey, El-Hag, & Daleiden, 1996). As a result, developmental models have begun to recognise that this is a risk factor linked to anxiety (for reviews, see Field & Lester, 2010; and Muris & Field, 2008). These propose an innate attentional bias for threat that becomes more regulated with age in children at low risk for anxiety, but less regulated in those at risk for anxiety (Kindt, Bierman, & Brosschot, 1997; Kindt & Brosschot, 1999; Kind & van den Hout, 2001; Kindt, van den Hout, de Jong, & Hoekzema, 2000). More recently, it has been hypothesised that providing children with negative verbal information (e.g., “[imaginary animal] is dangerous and hunts other animals”) can result in the acquisition of an attentional bias for a threatening stimulus (e.g., the imaginary animal) and that trait anxiety mediates this process (Field & Lawson, 2003; Field, 2006). However, a number of studies have failed to find any differences in attentional bias between anxious and non-anxious children (e.g., Benoit, McNally, Rapee, Gamble, & Wiseman, 2007; Kallen, Ferdinand, & Tulen, 2007; Kindt, Bierman, & Brosschot, 1996, 1997; Kindt, Brosschot, & Everaerd, 1997; Visu-Petra, Tincas, Cheie, & Benga, 2010). Furthermore, the effects of anxiety on *temporal* attention are yet to be investigated in child populations.

Given that findings in relation to child anxiety are both mixed and scant, there is a need to further investigate this area. In addition, there is a need to examine the temporal aspects of attentional bias. Thus, the aim of the present thesis is to address these gaps in current knowledge. This will enable a greater understanding of the role of attentional processing in children with a tendency towards anxiety. This will not only aid a better

understanding of the development of this disorder, but also vulnerability and maintenance factors. Importantly, future studies could then address the relevance of attentional bias for the treatment of childhood anxiety. If attentional bias is involved in the maintenance and/or exacerbation of anxiety in children, it is reasonable to assume that a reduction in specific biases would result in a decrease of anxiety symptoms (Muris & Field, 2008). Certainly, attention training that is utilised to successfully attenuate attentional bias in adults (for a review, see Mohlman, 2004) may also be of benefit to children (Muris & Field, 2008).

1.5 Thesis Aims and Objectives

To conclude, there is now considerable evidence for the existence of an attentional bias for threatening stimuli in anxious adults. More specifically, the components referred to as facilitated engagement, impaired disengagement and avoidance have all been demonstrated. However, research regarding children is currently scant and findings that do exist are mixed. Furthermore, theories that have been postulated in this area mainly relate to adults and are not able to explain all components of attentional bias. Thus, the current thesis will investigate the effects of state and trait anxiety on visual attention for emotive stimuli in children utilising the rapid serial visual presentation (with the attentional blink) and visual probe paradigms [see Chapter 2, sections 2.2 and 2.3 for details] to account for temporal and spatial biases of attention, respectively. The specific aims and objectives are as follows:

Aim 1: To investigate the effects of state and trait anxiety on *temporal* attention for emotive stimuli in children. In relation to this, the objectives are to determine whether children with high, relative to low, levels of anxiety demonstrate:

- i) *facilitated engagement* to threatening stimuli, and/or
- ii) *impaired disengagement* from threatening stimuli.

Aim 2: To investigate the effects of state and trait anxiety on *spatial* attention for emotive stimuli in children. In relation to this, the objectives are to determine whether children with high, relative to low, levels of anxiety demonstrate:

- i) *facilitated engagement* to threatening stimuli, and/or
- ii) *impaired disengagement* from threatening stimuli,
- iii) *avoidance* of threatening stimuli.

Following a review of methodology and research [*Chapter 2*], the current thesis is divided into two parts: the first includes attentional blink studies to investigate temporal biases of visual attention (aim 1); the second includes visual probe studies to investigate spatial biases of visual attention (aim 2).

CHAPTER 2

Methodology and Research Overview

2.1 Introduction

Threat-related attentional bias has been assessed utilising different methodologies, including neuroscience (e.g., electroencephalography, functional magnetic resonance imaging, magnetoencephalography, and positron emission tomography), behavioural (e.g., approach-avoidance and facial electromyography) and cognitive techniques (e.g., modified Stroop, rapid serial visual presentation and the attentional blink, visual search, spatial cueing, and visual probe). The latter cognitive techniques are the most frequently applied methodologies in this area and have been acknowledged to assess various facets of attention (e.g., Shalev & Algom, 2000); more specifically, rapid serial visual presentation and the attentional blink allows for investigation of temporal attention, whereas visual search, spatial cueing, and visual probe tasks measure spatial attention. It is important to note that the facilitated engagement and impaired disengagement components of attentional bias apply to both the temporal and spatial domains, whereas the more recent phenomenon of avoidance solely applies to the spatial domain. Thus, it is necessary to consider cognitive techniques that are able to differentiate between the suggested three components in *both* attentional domains. As such, this chapter will begin by reviewing the main cognitive techniques utilised to investigate attentional bias in the temporal domain followed by those utilised to investigate attentional bias in the spatial domain. This will be followed by a summary of the key findings relating to the different components of threat-related attentional bias in anxiety. Justification for the main stimulus category employed in this thesis will also be provided.

2.2 Cognitive Techniques Investigating Temporal Attention

2.2.1 *Rapid Serial Visual Presentation with the Attentional Blink*

In recent years there has been a surge of interest amongst researchers in how attention is biased across time (i.e., ‘temporal’ attention; see Dux & Marois, 2009; Shapiro, Arnell, & Raymond, 1997 for reviews). Typically, the temporal domain of attentional bias is explored

utilising the rapid serial visual presentation (RSVP; Potter & Levy, 1969) paradigm. In one version of this paradigm, two different target items are embedded in a stream of distracter stimuli with each item presented in rapid succession. Following each trial, participants are required to correctly identify the target items. Normally, when two target stimuli are presented within approximately 200-400 milliseconds (ms) of each other, participants are unable to report the second target (T2) accurately, despite having reported the first target (T1) correctly (e.g., Broadbent & Broadbent, 1987; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). This cognitive phenomenon is referred to as the ‘attentional blink’ (AB; Raymond et al., 1992). According to cognitive theories, the AB reflects competition between target items for attentional resources including attentional selection, working memory encoding, episodic registration and response selection (e.g., Chun & Potter, 1995; Nieuwenstein, 2006; Olivers & Meeter, 2008; Di Lollo, Kawahara, Ghorashi, & Enns, 2005). That is, allocating these attentional resources to the T1 renders them temporarily unavailable for processing subsequent information, thus impeding the report of the T2 at short lags (for reviews, see Dux & Marois, 2009; Shapiro, Arnell, & Raymond, 1997).

Studies employing RSVP to investigate the AB have found that the duration and magnitude of the AB is affected by the saliency of the T2 stimulus. For example, Shapiro, Caldwell, and Sorensen (1997) found that participants were more successful at reporting the T2 when this appeared as their name rather than a neutral word. That is, the AB effect was reduced when the T2 stimulus in the RSVP stream was of semantic significance to the participant. Research investigating emotional saliency has incorporated words (Anderson, 2005; Anderson & Phelps, 2001; Keil & Ihssen, 2004; Ogawa & Suzuki, 2004; Raymond et al., 1992; Shapiro, Caldwell, & Sorensen, 1997) and pictures (de Jong, Koster, van Wees, & Martens, 2009; Mack, Pappas, Silverman, & Gay, 2002; Maratos, Mogg, & Bradley, 2008; Milders, Sahraie, Logan, & Donnellon, 2006; Miyazawa & Iwasaki, 2010; Srivastava, & Srinivasan, 2010) as the target stimuli to demonstrate that the AB effect is diminished when the T2 stimulus appears as emotive, in particular, threatening, compared with neutral. These findings provide evidence for the facilitated engagement component of attentional bias.

Another question that has been explored with the AB task is the effect of presenting a salient stimulus as the T1 on the processing of a subsequent neutral stimulus as the T2. Manipulating the first target in this manner enables researchers to assess the effect of emotive stimuli on the processing of subsequent neutral stimuli. The majority of studies incorporating

words (Huang, Baddeley, & Young, 2008; Mathewson, Arnell, & Mansfield, 2008) or pictures (Ciesielski, Armstrong, Zald, & Olatunji, 2010; Maratos, 2011; Most, Chun, Widders, & Zald, 2005; Peers & Lawrence, 2009; Smith, Most, Newsome, & Zald, 2006; Srivastava & Srinivasan, 2010) as the target stimuli have found that the AB is increased when the T1 stimulus is negatively valenced, suggesting that these stimuli require more attentional resources to process than neutral stimuli. These findings provide evidence for the impaired disengagement component of attentional bias.

Considering the above, an advantage of utilising RSVP with the AB is that it allows for the investigation of both the facilitated engagement and impaired disengagement components of attentional bias in the temporal domain. Furthermore, the AB task is flexible in that it has been successfully undertaken by a variety of adult populations, such as brain-damaged patients (Rizzo, Akutso, & Dawson, 2001), schizophrenics (Cheung, Chen, Chen, Woo, & Yee, 2002), and the elderly (Lahar, Isaak, & McArthur, 2001). According to Visser, Boden and Giaschi (2004), this suggests that the AB task can also be employed to successfully examine attentional allocation in children.

2.3 Cognitive Techniques Investigating Spatial Attention

To date, the majority of studies investigating visual attentional bias have focused on the spatial domain (e.g., see Carrasco, 2011; Peterson & Posner, 2012 for reviews). Below follows a brief review of the three most utilised paradigms.

2.3.1 Visual Search

One paradigm that has been employed to investigate spatial attentional bias is the visual search task (Hansen & Hansen, 1988; Öhman, Flykt, & Esteves, 2001). This involves presenting a target stimulus embedded in an array of distracting stimuli. For example, a threatening face is presented in a matrix (typically a four row by four column pattern) of neutral or positive faces; conversely, a neutral or positive face is embedded in a matrix of threatening faces. Participants are required to search for and identify the target stimulus as quickly and as accurately as possible. Attentional bias can be indicated by faster response times to detect threat-related targets embedded in an array of neutral or positive faces compared with neutral or positive targets embedded in an array of threatening faces. Cisler and Koster (2010) have suggested that this demonstrates facilitated engagement to threat.

Attentional bias can also be indicated by slower response times to detect neutral or positive targets embedded in an array of threatening faces compared with neutral or positive targets embedded in an array of neutral or positive faces. This is thought to demonstrate difficulties in disengagement from threat (Cisler & Koster, 2010). However, a limitation of the visual search task is that young children find it difficult to effectively monitor across multiple possible target dimensions (Donnelly et al., 2007; Gerhardstein & Rovee-Collier, 2002; Trick & Enns, 1998). Additionally, the visual search task has been criticised with the argument that attentional bias may be goal dependent because participants are directly instructed to search for either a positive or a threatening face (Smith et al., 2006).

2.3.2 Spatial Cueing

A further paradigm that has been utilised to investigate spatial biases of attention is the spatial cueing task (Fox, Russo, Bowles, & Dutton, 2001). Based on Posner's cueing paradigm (1980), this involves participants focusing on a central fixation point whilst a single cue is presented in one of two locations (e.g., left or right). This is then followed by a single target that appears at either the same location as the cue (a congruent trial) or at the opposite location (an incongruent trial). Participants are required to respond to the target as quickly and as accurately as possible. In the emotive version of the task, schematic or photographic pictures of threatening (e.g., angry), happy, or neutral faces are included as the cues (e.g., Fox, Russo, & Dutton, 2002; Verkuil, Brosschot, Putman, & Thayer, 2009). Attentional bias is inferred from faster response times on congruent threat-cued trials relative to neutral- or positive-cued trials. Attentional bias is also inferred from slower response times on incongruent threat-cued trials relative to neutral- or positive-cued trials. A criticism of the spatial cueing task is that it involves presenting only one stimulus prior to the target. This means that any differences in the initial tendency to prioritise attention for one stimulus over another cannot be determined. Thus, the spatial cueing task is limited in that it can only be employed to investigate the disengagement component of attentional bias (Fox et al., 2002). Furthermore, incorporating just one stimulus limits ecological validity since it does not offer a method of investigating competition between stimuli (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007).

2.3.3 Visual Probe

The visual probe (VP; MacLeod, Mathews, & Tata, 1986) task is now the most frequently applied methodology utilised to explore the effects of anxiety on spatial biases of attention (Staugaard, 2010). In a typical version of the VP task, a pair of stimuli (e.g., facial expressions) flanks a central fixation on a visual display (e.g., computer monitor). One of the stimuli is emotive (e.g., an angry or happy facial expression) and the other is neutral. The pair is presented briefly (typically for 500 ms; see Mogg & Bradley, 1998 for a review) before vanishing and being replaced immediately by a probe (e.g., an asterisk or a dot). The probe appears in one of the locations previously occupied by a stimulus; it can appear in the place of the emotive or the neutral stimulus. This is done in a semi-randomised sequence to ensure that probes are counter-balanced, that is, replace an equal number of emotive and neutral faces presented above and below / to the left and right of the fixation. Trials in which the probe appears in the place of the emotive stimulus are known as ‘congruent’ and trials in which the probe appears in the place of the neutral stimulus are known as ‘incongruent’. Participants are then required to respond to the probe as quickly and as accurately as possible either by indicating when the probe appears or by classifying its location (e.g., left vs. right) / type (e.g., : vs. ..), depending on the task version. It is hypothesised that individuals respond more rapidly to a probe when it appears in an attended, as opposed to an unattended, spatial location (Posner, Snyder, & Davidson, 1980). Thus, a fast reaction time to a congruent, compared to an incongruent, trial indicates enhanced attention to an emotive stimulus and/or diminished attention to a neutral stimulus. In contrast, a slow reaction time to a congruent, compared to an incongruent, trial indicates diminished attention to an emotive stimulus and/or enhanced attention to a neutral stimulus.

The VP task has several advantages over other paradigms that measure spatial attentional bias. For example, it is more suited to the presentation of pictorial stimuli compared with other measures. Facial stimuli are increasingly being incorporated in attentional bias tasks because it is understood that faces are especially meaningful and salient for humans (Adolphs, 2002, 2003; Darwin, 1872; Ekman & Friesen, 1969; Kolassa et al., 2009; Öhman, 1996), thus allowing for greater ecological validity. Another advantage of the VP task is that it encourages competition among stimuli, which may be a prerequisite for attentional bias to emerge (Bar-Haim et al., 2007). This is because multiple stimuli often compete for our attention in the natural environment. Therefore, the VP task may be a more sensitive measure of spatial attention than paradigms that utilise single stimulus presentation

such as the spatial cueing task. Furthermore, the VP task allows for manipulation of the stimulus onset asynchrony (i.e., the time interval between stimuli and probe presentation), meaning that the time course of attentional allocation can be investigated.

However, a limitation of the VP task is that it provides just a snap-shot of attentional allocation at a specified time-point. In other words, the measure is not sensitive to participants' shifts in attention that may occur repeatedly throughout the duration of each trial (Caseras, Garner, Bradley, & Mogg, 2007), especially when longer stimulus durations are employed. Consequently, it is beneficial to combine the VP task with eye tracking (ET) technology.

2.3.4 Visual Probe with Eye Tracking

ET provides a continuous measure of the exact position of eye gaze, making it one of the most direct methods of investigating overt attention (Bögels & Mansell, 2004). Furthermore, this method offers greater ecological validity (Caseras et al., 2007), since the direction of gaze is closely linked to what one perceives (Aslin & McMurray, 2004). ET provides measures of initial orienting (as reflected by the direction and latency of the first shift in gaze) and maintenance / shifts of attention (as indexed by gaze duration). As such, this methodology is able to help determine whether participants initially attend to a particular stimulus type, remain fixed on a specific stimulus type, shift attention back and forth in an unstable manner (e.g., Garner, Mogg, & Bradley, 2006), or avoid stimuli at longer presentation times (Frewen, Dozois, Joanisse, & Neufeld, 2008). This makes ET an effective methodology for testing the vigilance-avoidance theory (Mogg & Bradley, 1998; Mogg, Bradley, de Bono, & Painter, 1998; Mogg, Mathews, & Weinman, 1987) [*described in Chapter 7, section 7.1*].

2.4 Anxiety and Temporal Attentional Bias Research

2.4.1 Facilitated Engagement

Relatively few studies have utilised RSVP with the AB to investigate the effects of anxiety on the temporal processing of emotive stimuli. Of those that have, the majority have involved manipulating the T2 to allow for the investigation of facilitated engagement. Such studies have demonstrated that the reduction in the AB effect is particularly pronounced for anxious individuals compared with controls (arachnophobia - D'Alessandro, Gemignani,

Castellani, & Sebastiani, 2009; Reinecke, Rinck, & Becker, 2008; Trippe, Hewig, Heydel, Hecht, & Miltner, 2007; state and/or trait anxiety - Arend & Botella, 2002; Barnard, Ramponi, Battye, & Mackintosh, 2005; Fox, Russo, & Georgiou, 2005; Vaquero, Frese, Lupianez, Megias, & Acosta, 2006). Additionally, although these findings are robust, it appears that no child studies involving this task are currently in existence.

2.4.2 Impaired Disengagement

To date, few studies of anxiety have explored the effects of emotive stimuli presented as the T1 on the processing of subsequent neutral stimuli. Of those that have, the research has focused on adult populations and findings have demonstrated either impaired (Barnard et al., 2005; Most et al., 2005) or *rapid* disengagement from threat (Amir, Taylor, Bomyea, & Badour, 2009; Arend & Botella, 2002; Cisler, Ries, & Widner, 2007; Lystad, Rokke, & Stout, 2009).

2.5 Anxiety and Spatial Attentional Bias Research

2.5.1 Facilitated Engagement

Visual search studies incorporating either schematic or photographic faces have typically demonstrated facilitated engagement to threatening, compared with neutral or happy, expressions among anxious individuals (Byrne & Eysenck, 1995; Eastwood et al., 2005; Gilboa-Schechtman, Foa, & Amir, 1999; Juth, Lundqvist, Karlsson, & Öhman, 2005; Miltner, Krieschel, Hecht, Trippe, & Weiss 2004; Rinck, Becker, Kellermann, & Roth, 2003; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005). Research involving the visual search task and threat detection in anxious children is scant, possibly due to the limitation highlighted in section 2.3.1.

The spatial cueing paradigm has often failed to find any evidence of facilitated engagement to threat in anxious adults (Amir, Elias, Klumpp, & Przeworski, 2003; Fox et al., 2002; Yiend & Mathews, 2001). This is because the paradigm is limited in that it does not allow any differences in the initial tendency to prioritise attention for one stimulus over the other to be determined [*see section 2.3.2*]. To date, the spatial cueing task does not appear to have been utilised to investigate the effects of anxiety on attentional bias in children.

VP research that has incorporated short stimulus exposure durations has provided consistent evidence that anxious, relative to non-anxious, individuals are faster to respond to

probes that replace threatening rather than neutral faces, thus reflecting an attentional bias towards threat. These findings have been demonstrated in both clinical (e.g., generalised anxiety disorder - Bradley, Mogg, White, Groom, & de Bono, 1999; social anxiety disorder - Mogg, Phillipott, & Bradley, 2004) and non-clinical anxious populations (e.g., Bradley, Mogg, Falla, & Hamilton, 1998; Ioannou, Mogg, & Bradley, 2004; Mogg & Bradley, 1999). Additionally, studies that have investigated ‘subliminal’ exposures have provided evidence of an early (often suggested automatic/preconscious) attentional bias for threatening stimuli in both clinical (generalised anxiety - Mathews & MacLeod, 1986; social anxiety - Mogg & Bradley, 2002) and non-clinical anxiety (Bradley, Mogg, & Lee, 1997).

Child VP studies employing word stimuli have reported findings similar to those from adult studies in that an attentional bias towards threat stimuli has been found in anxious relative to non-anxious children (e.g., Hunt, Keogh, & French, 2007; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999; Vasey, Daleiden, Williams, & Brown, 1995). In regards to emotive facial expressions, an attentional bias towards angry faces has been revealed in clinically anxious children (Roy et al., 2008), those with both current bipolar and a lifetime history of anxiety (Brotman et al., 2007), and non-selected children with high levels of trait anxiety (Telzer et al., 2008).

Little research has incorporated the combined measures of ET and the VP paradigm to assess the relationship between anxiety and spatial attentional bias. Research that has so far been conducted typically concerns adult populations, revealing faster and more frequent initial orienting to threatening facial stimuli in anxious individuals (Bradley, Mogg, & Millar, 2000; Garner et al., 2006; Mogg, Garner, & Bradley, 2007; Mogg, Millar, & Bradley, 2000; Rohner, 2002). As highlighted by In-Albon and Schneider (2010), ET studies in this area with children are rare. To date, it appears that only two studies have measured eye movements to investigate the time course of attentional bias in anxious children (Gamble & Rapee, 2009; In-Albon, Kossowsky, & Schneider, 2010).

2.5.2 Impaired Disengagement

Studies utilising the visual search task have consistently found impaired disengagement from (as well as facilitated engagement to) threatening faces compared with neutral or happy faces among anxious individuals (Byrne & Eysenck, 1995; Eastwood et al., 2005; Gilboa-Schechtman et al., 1999; Juth et al., 2005; Miltner et al., 2004; Rinck et al., 2003; Rinck et al., 2005; *cf.* Pflugshaupt et al., 2005). Findings from the spatial cueing task

have also tended to demonstrate impaired disengagement of spatial attention from threat in anxious adults (Amir et al., 2003; Cisler & Olatunji, 2012; Fox, Russo, & Dutton, 2002; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, Crombez, Verschuere, & De Houwer, 2004; Van Damme, Crombez, Hermans, Koster, & Eccleston, 2006; Yiend & Mathews, 2001). It is only recently that VP research has begun to distinguish the different components of attentional bias. Such research involving short stimulus exposure durations has revealed impaired disengagement from threatening stimuli in anxious individuals (Koster, Crombez, Verschuere, & De Houwer, 2006; Koster, Crombez, Verschuere, & De Houwer, 2004; Salemink, van den Hout, & Kindt, 2007; *cf.* Carlson & Reinke, 2008).

2.5.3 Avoidance

Avoidance of threat in anxious individuals has only been demonstrated for spatial attention utilising long stimulus exposure durations (e.g., 1500 ms). For instance, Koster, Verschuere, Crombez, and Van Damme (2005) conducted a VP study involving varying stimulus times and found that high trait anxious adults responded slower to probes that replaced threatening pictures compared to probes that replaced neutral stimuli presented for 1250 ms. In contrast, an exposure duration of 500 ms resulted in these participants responding faster to probes that replaced threatening, relative to neutral, stimuli, thus demonstrating facilitated engagement to threat.

The finding that anxious adults avoid threatening stimuli exposed for long durations has been replicated in VP studies (Garner et al., 2006; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2005; Mogg et al., 2004), visual search studies (Pflugshaupt et al., 2005), and spatial cueing studies (Koster et al., 2006). It has also been demonstrated when directly measuring eye movements (Calvo & Avero, 2005; Garner et al., 2006; Pflugshaupt et al., 2005; Rohner, 2002): High anxious participants initially display rapid eye movement fixations towards threatening stimuli (i.e., facilitated engagement) but subsequently display eye movement fixations away from such stimuli (i.e., avoidance). Nevertheless, there is adult research involving similar methodologies that has failed to find support for this avoidance effect at long stimulus durations (Bradley et al., 1998; Mogg et al., 1998).

In regards to child research, avoidance of angry faces has been found utilising the VP task in non-selected children with high levels of social anxiety (Stirling, Eley, & Clark, 2006) and those diagnosed with generalised anxiety disorder (Monk et al., 2008).

2.6 Stimulus Type

A varying feature of the techniques reviewed in this chapter is the type of stimulus that has been employed to investigate the effects of anxiety on attentional bias. A limitation of several studies is the inclusion of letters, numbers, or words (i.e., typography). This is because it has been proposed that attentional prioritisation should be particularly evident for biologically relevant stimuli, such as fear-related animals (e.g., snakes, spiders) and threatening emotive expressions (e.g., angry, fearful), given that the ability to efficiently process such stimuli is advantageous in terms of survival/well-being (LeDoux, 1996; Öhman, 1996). Another disadvantage of utilising typographical stimuli is that reading ability may act as a potential confound, particularly for children younger than approximately eleven years (La Roque & Visser, 2009; Lumm, Conti-Ramsden, & Lindell, 2006; McLean, Stuart, Visser, & Castles, 2009). As a consequence, it is more appropriate to investigate attentional bias for threat utilising biologically relevant, pictorial stimuli.

Research displaying pictorial stimuli has differed in regard to whether it has featured aversive scenes, fear relevant animals, or threat-related facial expressions. Though it may be more appropriate to include fear congruent pictures when investigating specific phobias, research has demonstrated that faces are an especially meaningful and salient stimulus for humans (Adolphs, 2002, 2003; Darwin, 1872; Ekman & Friesman, 1969; Kolassa et al., 2009; Öhman, 1996). According to Ekman (1992), a core set of facial expressions associated with specific emotions are recognised across cultures: *anger*, *fear*, *happiness*, *sadness*, and *disgust*. Thus, there appear to be four culturally recognised negative expressions, of which anger and fear are the only two considered to be threatening (LeDoux, 1996; Öhman, 1996). As such, research into the effects of anxiety on visual attention for emotive stimuli typically includes angry or fearful faces as the threatening expression and happy faces as the positive expression.

However, the use of fearful expressions has been criticised since they are proposed to communicate *indirect* threat that relates to potential danger in the surrounding environment (Bannerman, Milders, de Gelder, & Sahraie, 2009). In contrast, an angry face is *directly* threatening because it communicates possible direct and immediate harm to an individual. Thus, it is argued that angry faces are more efficient at capturing visual attention (especially in anxious individuals), and as such, these stimuli will be included in the present thesis.

In conclusion, it is reasonable to presume that the most effective stimuli for investigating the effects of anxiety on visual attentional bias in children are facial expressions, in particular, angry and happy faces.

2.7 Summary

The present chapter has outlined several different cognitive techniques that could be utilised to investigate the three components of attentional bias outlined in Chapter 1 (i.e., facilitated engagement, impaired disengagement, and avoidance; see section 1.3.2) with child populations. These include the RSVP (with the AB), visual search, spatial cueing, and VP paradigms.

From reviewing these various paradigms and summarising the key related findings, it is apparent that RSVP with the AB is an appropriate technique for investigating temporal attention, as it has consistently demonstrated both evidence of facilitated engagement to and impaired/rapid disengagement from, threat in anxious adults. It can also be surmised that VP (with and without ET) is the most suitable technique for investigating spatial attention. This is because the VP task is the *only* measure of spatial attention shown to provide replicable and robust evidence for all three components of attentional bias (especially when utilised with ET methodology). Considering the above, the present thesis incorporated RSVP with the AB, and VP methodology to comprehensively investigate temporal and spatial components of attentional bias, respectively.

Research into the effects of anxiety on attentional bias has also differed in regards to the type of stimuli included; whether these are typographical or pictorial. The current PhD incorporated facial stimuli, since it is thought that these are more ecologically valid and salient than other types of stimuli (LeDoux, 1996; Öhman, 1996).

To sum, a review of these methods resulted in the decision that the AB and VP tasks (with and without ET) would be the most suitable techniques for assessing the effects of anxiety on visual attention for threat in children, utilising angry faces as the specific threat stimulus. This particular use of RSVP in child populations is novel, as is this particular use of the VP paradigm.

CHAPTER 3

Investigations One and Two: The Non-Emotive and the Emotive Attentional Blink Task

The current chapter reports both a non-emotive and an emotive version of the attentional blink task. The former acted as a control study whilst the latter was designed to investigate the facilitated engagement component of attentional bias. Both investigations are reported here given that the same participant pool was utilised.

3.1 Introduction

The majority of studies exploring the mechanisms of visual attention have focused on how stimuli distributed across space are processed (i.e., spatial attention; e.g., see Carrasco, 2011; Peterson & Posner, 2012 for reviews). However, researchers have recently begun to investigate how visual attention is deployed across time (i.e., temporal attention; see Dux & Marois, 2009; Shapiro, Arnell, & Raymond, 1997 for reviews). Research exploring the temporal domain of visual attention typically involves utilising rapid serial visual presentation (RSVP; Potter & Levy, 1969). To review, this paradigm requires participants to identify one or two different target items that are embedded in a stream of distracter stimuli and presented in rapid succession [*see Chapter 2, section 2.2.1*]. This method of investigation was initially utilised to determine the time constraints of visual attention in adults (for reviews, see Dux & Marios, 2009; Shapiro et al., 1997). Over 40 years ago, Lawrence (1971) determined that individuals are able to successfully process and report single targets presented in an RSVP stream for approximately 100 milliseconds (ms) each. However, further research has demonstrated that when an extra target is embedded in the stream, individuals are unlikely to successfully report a second target (T2) if it appears within approximately 200-400 ms of a first target (T1; Broadbent & Broadbent, 1987; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). This effect has been termed the ‘attentional blink’ (AB) by Raymond and colleagues (1992). It is postulated that the AB is caused by focusing attentional resources (i.e., attentional selection, working memory encoding, episodic registration, and response selection) completely on the

T1, thus rendering resources temporarily unavailable for processing the T2 within this short time period (see Dux & Marois, 2009; Shapiro et al., 1997 for reviews).

More recently, studies have revealed that the AB (i.e., the processing deficit associated with the T2) can be reduced by presenting an emotionally salient, in particular, threatening, stimulus as the T2 (word stimuli - Anderson, 2005; Anderson & Phelps, 2001; Keil & Ihssen, 2004; Kihara, & Osaka, 2008; Ogawa & Suzuki, 2004; Raymond et al., 1992; Shapiro et al., 1997; pictorial stimuli - de Jong, Koster, van Wees, & Martens, 2009; Maratos, Mogg, & Bradley, 2008; Milders, Sahraie, Logan, & Donnellon, 2006; Srivastava & Srinivasan, 2010). For instance, Maratos et al. (2008) incorporated angry, positive and neutral schematic facial expressions to assess the effects of emotive stimuli on the depth and temporal resolution of the AB in a sample of University students. Participants were asked to indicate the number of targets presented and the expression of the last face viewed. Findings demonstrated that a participant's ability to accurately identify the expression of a facial stimulus in an RSVP stream of distracters (i.e., scrambled faces) was enhanced when the T2 appeared as threatening, relative to neutral. More specifically, the AB was attenuated for angry faces when the T2 appeared within 257 to 388 ms of the T1 (i.e., Lags 2 to 3). This finding is important because it is one of the few studies to incorporate facial, as opposed to typographical, stimuli as both targets. The finding that an angry face 'breaks through' the AB accords well with both cognitive and neural models of emotion. These models typically assume that attentional resources are preferentially assigned to threatening, relative to non-threatening, information (e.g., Davis & Whalen, 2001; LeDoux, 1996; Mogg & Bradley, 1998; Öhman, 1996; Pessoa, 2005). Indeed, according to LeDoux (1996) and Öhman (1996), attentional prioritisation should be particularly apparent for biologically prepared stimuli, such as fear-related animals (e.g., snakes) and threatening emotive expressions (e.g., an angry face), as the ability to efficiently process such stimuli is advantageous in terms of survival/well-being. For example, rapid identification of danger enables the early activation of defence mechanisms (LeDoux, 1996; Öhman, 1996). The finding of Maratos et al. (2008) is consistent with this theory as it demonstrates rapid processing of threatening stimuli.

The preferential and efficient processing of angry faces is often referred to as the 'anger-superiority effect' (de Jong et al., 2009). Whilst this effect appears to be both replicable and robust, recent AB studies have also provided evidence of a 'happiness-superiority' effect (Miyazawa & Iwasaki, 2010; Srivastava & Srinivasan, 2010) or an 'emotion-superiority' effect per se (de Jong & Martens, 2007; de Jong et al., 2009). For

instance, Miyazawa and Iwasaki (2010) investigated the influence of positive stimuli on the AB in an undergraduate student population utilising schematic faces (i.e., angry, happy and neutral) as the T2 and flower symbols as the T1. Participants were required to indicate both the number and type of targets seen. Findings revealed that the AB was reduced for happy compared with both angry and neutral schematic faces and that this effect was independent of lag position. In a further study, de Jong et al. (2009) found that the AB was similarly reduced for both angry and happy faces. Here, the researchers presented an RSVP paradigm to high and low socially anxious women, which included photographs of angry, happy and neutral faces as the T2 and neutral letter stimuli as the T1. Again, participants were required to indicate both the number and type of target(s) seen. It was demonstrated that the AB effect was reduced when the T2 appeared as an emotive, relative to a neutral, face and that this was irrespective of social anxiety level. Thus, the findings discussed so far imply that individuals preferentially allocate temporal attentional resources to emotive stimuli in general.

It has been established that the attenuation of the AB effect is particularly pronounced for those with certain psychopathological disorders and especially for stimuli that are threat-related. For example, research into the effects of anxiety has demonstrated that those with higher levels of clinical anxiety (i.e., specific phobia; D'Alessandro, Gemignani, Castellani, & Sebastiani, 2009; Reinecke, Rinck, & Becker, 2008; Trippe, Hewig, Heydel, Hecht, & Miltner, 2007) or non-clinical anxiety (i.e., state and/or trait anxiety; Barnard, Ramponi, Battye, & Mackintosh, 2005; Fox, Russo, & Georgiou, 2005; Jefferies, Smilek, Eich, & Enns, 2008; Vaquero, Frese, Lupianez, Megias, & Acosta, 2006) are more likely to report the T2 when it appears as a threatening, relative to a neutral, stimulus. Of those studies investigating state and/or trait anxiety, the majority have incorporated typographical stimuli. Consequently, as highlighted by Anderson (2005), they are limited in theoretical interpretation because they do not address the predictions made by LeDoux (1996) and Öhman (1996).

An AB study that has included facial stimuli is that of Fox et al. (2005). In this research, adults who varied in levels of state and trait anxiety were exposed to an AB task utilising photographs of fearful or happy faces as the T2 stimulus and photographs of flowers or mushrooms as the neutral T1 stimulus. The distracter stimuli consisted of photographs of neutral faces. Participants were required to indicate whether or not an emotive face had been presented as the T2 and whether the T1 was a flower or mushroom. For low anxious individuals, the AB effect was found to be robust for both happy and fearful faces. For high anxious participants, however, the magnitude of the AB effect for fearful faces was both

significantly reduced and shorter in duration (i.e., only apparent up to Lag 2 / approximately 330 ms). Therefore, high anxious participants: i) were more accurate at identifying fearful expressions in the AB period than low anxious participants; and ii) recovered faster from the AB for these stimuli than did low anxious participants. Accordingly, the authors argue that anxiety is associated with a reduced ability to inhibit the processing of threat-related information. This is consistent with several theories of anxiety and attentional bias (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Beck & Clark, 1997; Mathews & Mackintosh, 1998; Mathews, Mackintosh, & Fulcher, 1997; Mogg & Bradley, 1998; Öhman, 1996; Wells & Matthews, 1994; Williams, Watts, MacLeod, & Mathews, 1988, 1997).

A limitation of the Fox et al. (2005) study, however, is that the target items differed categorically (i.e., the T1 was a flower/mushroom, whereas the T2 was a face). Thus, the paradigm included an additional component of task switching. Not only does this complicate findings with regards to underlying mechanisms, it could also compromise study validity (see, for example, Derakshan, Smyth, & Eysenck, 2009). A further limitation of this research is that it incorporated fearful faces, which are argued to be less directly threatening than angry faces and subsequently less efficient at capturing visual attention (Bannerman, Milders, de Gelder, & Sahraie, 2009; see Chapter 2, section 2.6 for further discussion).

Thus far, there is little research involving processing speeds and the AB in child populations. Furthermore, it appears that studies are yet to investigate the development of anxiety in relation to temporal attention. This is despite theories claiming that the speed of processing threat is associated with the activation of innate defence mechanisms (LeDoux, 1996; Öhman, 1996), indicating that like adults, children should display a greater degree of prioritisation for threatening stimuli, especially those with high levels of anxiety. A possible reason for this lack of research is that RSVP and AB methodologies typically require participants to identify typographical (i.e., letter or word) stimuli. This is problematic for younger children (e.g., eleven years and below) since reading ability may act as a potential confound (La Rocque & Visser, 2009; Lumm, Conti-Ramsden, & Lindell, 2006; McLean, Stuart, Visser, & Castles, 2009). For instance, McLean et al. (2009) found that reading ability in children with normal-range reading skills affected performance on an AB task, such that less skilled readers displayed reduced performance in reporting both the T1 and T2. As findings did not depend on the temporal lag between the targets, this indicated a general deficit.

In addition, processing speed has been found to vary from childhood to adolescence (see Kail, 1991; Ridderinkhof & van der Stelt, 2000, for reviews), suggesting that children are not necessarily capable of processing consecutively presented stimuli at the same rate as adults (Crocker & Maratos, 2011). Very recent studies have further demonstrated that the ability to process consecutively presented stimuli at rapid rates can also vary depending on the exact age group of a child. For example, Heim, Wirth and Keil (2011) compared six to seven year olds with ten to eleven year olds in both pictorial (i.e., symbols) and typographical (i.e., letters) versions of the AB task. For both tasks, it was found that all children displayed a typical AB effect, such that the reporting of both targets was lowest at Lag 2 (i.e., 232 ms) and increased linearly with longer intervals, with highest accuracy at Lag 8 (i.e., 928 ms). However, it was also demonstrated that the older group outperformed the younger group overall (i.e., independent of the temporal lag between targets). Furthermore, Garrad-Cole, Shapiro, and Thierry (2011) compared seven, twelve and fifteen year old children in a pictorial version of the AB task. This time, results indicated that the duration of the AB was affected by age, such that seven year olds, relative to twelve and fifteen year olds, failed to recover from the AB within the range of lags included (i.e., Lag 1 to Lag 9 / 212 ms to 1060 ms). Garrad-Cole et al. (2011) propose that this finding is a direct result of the gradual development of the prefrontal cortex - a part of the brain that is likely to be associated with successful dual target identification (Kranzloch, Debener, Schwarzbach, Goebel, & Engel, 2005; Marois, Chun, & Gore, 2000).

Taken together, these child findings suggest that those aged seven and below do not process consecutively presented stimuli at the same rate as adults. These differences in children's processing speed may be another reason why research into the temporal domain of visual attention in children is sparse. That said, a limitation of the above cited studies (i.e., Garrad-Cole et al., 2011; Heim et al., 2011) is that they did not include eight or nine year old children, thus leaving it uncertain whether these children display a similar deficit in the AB task. In a study that did include a wider range of children (Crocker & Maratos, 2011), it was found that those aged eight years and above were able to discriminate facial stimuli presented every 100 ms, which is comparative to adolescents and adults (Lawrence, 1971). In this study, 99 children aged seven to eleven years were required to determine whether or not a schematic happy face was embedded in a stream of distracter stimuli (i.e., scrambled schematic faces). Presentation times varied from 500 ms to 100 ms in steps of 50 ms. Findings revealed that only those aged eight years or above could reliably identify the

absence or presence of target stimuli presented every 100 ms. In addition, these children were faster at responding, and completed a greater number of trials than younger children. According to the authors, these findings suggest that it is possible to reliably conduct RSVP/AB tasks with child participants utilising the same methodology employed with adult populations but, importantly, only with children aged eight years and over. It should be noted, however, that Croker & Maratos (2011) did not investigate the AB in their population, rather processing speeds per se.

To date, a small number of studies have now successfully investigated the AB in atypically developing child populations incorporating typographical (attention-deficit hyperactivity disorder - Mason, Humphreys, & Kent, 2005; Ray Li, Lin, Chang, & Hung, 2004; dyslexia - Facoetti, Ruffino, Peru, Paganoni, & Chelazzi, 2008; Lallier, Donnadieu, & Valdois, 2010) and pictorial stimuli (autism and Asperger's disorder - Rinehart, Tonge, Brereton, & Bradshaw, 2010; dyslexia - McLean, Castles, Coltheart, & Stuart, 2010; Visser, Boden, & Giaschi, 2004). The majority of this research has focused on dyslexia, with results typically demonstrating that dyslexic individuals perform worse on AB tasks, irrespective of the temporal lag between targets. However, these studies are limited by small sample sizes (e.g., less than 30) and the inability to generalise results to younger children (i.e., below nine years). Furthermore, no study to date has explored the effects of *anxiety* on temporal attention in children.

In consequence, prior to investigating whether levels of anxiety affect temporal attention for emotive stimuli, it is necessary to determine whether levels of anxiety affect children's processing speed per se and the manifestation of the AB in a non-emotive RSVP paradigm. Moreover, when investigating the effects of anxiety on temporal processing per se in children, it is important to ensure that a larger and more age appropriate sample is included. Thus, an initial control study was conducted that included the use of non-emotive stimuli (Investigation One). The main aim of this investigation was to determine whether eight to eleven year old children are subject to the same processing constraints as adults. That is, to establish whether these children also display an AB effect due to decreased ability to process targets presented within approximately 200-400 ms of each other. Two further aims included: i) to determine whether age affects the ability to temporally process consecutively presented non-emotive stimuli amongst eight to eleven year olds; and ii) to determine whether anxiety level affects the ability to temporally process consecutively presented non-emotive stimuli amongst eight to eleven year olds. To meet these aims, a selection of

geometric shapes was included as the target stimuli. These shapes have been successfully utilised in previous child studies of the AB (McLean et al., 2009; Visser et al., 2004).

Based on the findings of Croker and Maratos (2011), it was hypothesised that i) eight to eleven year old children would display an AB profile similar to that of adults. That is, all children would perform worse at earlier lag times (i.e., approximately 200-400 ms) compared with later lag times (i.e., over approximately 400 ms). On the basis of previous AB studies comparing age (e.g., Garrad, Cole et al., 2011; Heim et al., 2011), it was further predicted that ii) older children would outperform younger children overall. In relation to anxiety, it was hypothesised that iii) there would be no effects given that non-emotive stimuli were incorporated.

A second investigation was then conducted, which involved presenting participants with an emotive version of the AB task. The main aim of this investigation was to determine whether like adults, children with high levels of anxiety demonstrate facilitated engagement for angry, relative to positive and neutral faces. This was achieved by presenting participants with an AB task in which the emotive content of the T2 was manipulated. Faces were included as the T1 and T2 stimuli because of: i) their increased ecological validity over other pictorial and typographical stimuli; and ii) to prevent the potential confound of reading ability [*see Chapter 3, section 3.1, for further discussion*]. In particular, the stimuli consisted of angry, positive, and neutral facial expressions. An angry face was chosen as the threatening stimulus in light of the arguments that: i) it is a biologically prepared stimulus (LeDoux, 1996; Öhman, 1996); and ii) it is more efficient in capturing visual attention than a fearful face (Bannerman et al., 2009). In addition, Investigation Two incorporated schematic faces, given their advantages over real facial expressions and their suitability for use with children; that is, schematic faces are argued to offer an unambiguous representation of the key features of emotive expressions (Fox et al., 2000; Juth, Lundqvist, Karlsson, & Öhman, 2005; Öhman, Lundqvist, & Esteves, 2001) and to control for potential confounds that are more likely to occur when utilising real faces (e.g., individual differences in expressing emotion, gender, age or race effects, variation in physical features including contrast, luminance, etc.; see Öhman et al., 2001 for further discussion). Finally, the schematic faces included here have been utilised to good success in both a previous AB study with adults (e.g., Maratos et al., 2008) and an RSVP study with children (i.e., Croker & Maratos, 2011).

Based on previous research, it was hypothesised that all children would: iv) display an AB effect of increased magnitude at earlier lags (i.e., Lags 2 to 3; approximately 200 to 400

ms) compared with later lags (i.e., Lag 4 and over; over approximately 400 ms); and v) display an attenuated AB for emotive, relative to neutral, faces. It was further predicted that vi) high state and/or trait anxiety would be associated with an attenuated AB effect for angry, relative to positive and neutral faces. That is, high anxious children would demonstrate an enhanced threat-superiority effect.

3.2 Investigation One: The Non-Emotive Attentional Blink Task (A Control Study)

3.2.1 Methods

3.2.1.1 Participants

A total of 115 children (57 male, 58 female) aged eight to eleven years ($M = 9.36$, $SD = .92$) were recruited from three participating primary schools situated in the East Midlands, United Kingdom. The selection criteria were: i) normal or corrected-to-normal vision; ii) English as the first language; and iii) being free from developmental disorders and learning disabilities, based on teachers' judgments. Participating schools received £50 worth of book vouchers. Ethical approval was obtained from the University of Derby Psychology Research Ethics Committee.

3.2.1.2 Stimuli

Three basic outline shapes were included as the target stimuli: a square, triangle and circle [see Figure 3.1]. Previous studies have utilised these shapes to successfully investigate the attentional blink (AB) in both normally developing readers and children with dyslexia, with ages ranging from seven to fifteen years (McLean et al., 2009; Visser et al., 2004). Thirty distracter stimuli were also included, which consisted of lines taken from each outline shape placed in random positions and orientations [see Figure 3.2 for examples]. Stimuli were produced with the graphics editing software, Adobe® Photoshop® CS3 Extended (Version 10.0.01). All stimuli were displayed on a black background at a viewing distance of approximately 40 cm. Stimulus presentation was controlled with the experimental engine, Inquisit, developed by Millisecond software (www.millisecond.com). All stimuli subtended visual angles of $\sim 11 \times 11$ degrees when presented on the screen. Each stimulus was presented for eight screen refreshes at a 60 hertz (Hz) refresh rate resulting in a display time of approximately 134 milliseconds (ms). This speed was chosen as it has been found that

children aged eight years and over can successfully discriminate visual stimuli presented every 100 ms (Crocker & Maratos, 2011).

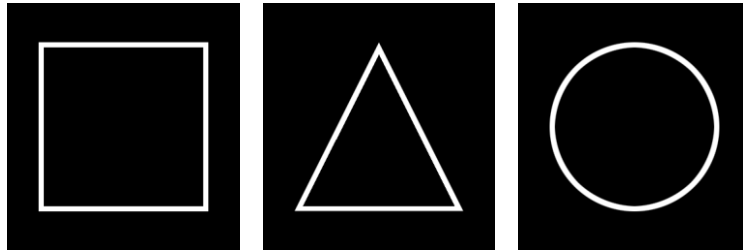


Figure 3.1 The shape stimuli utilised: a square, triangle and circle.

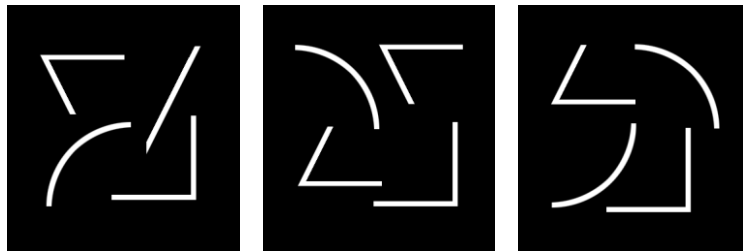


Figure 3.2 Examples of the distracter stimuli utilised.

3.2.1.3 Questionnaire Measures

3.2.1.3.1 Anxiety

The State-Trait Anxiety Inventory for Children (STAIC; Spielberger, 1973) was utilised to assess state and trait levels of anxiety [see Appendix A for a copy of the questionnaire]. It has been designed for use with children aged nine to twelve years but may be administered to younger children who have an average or above average reading ability (Spielberger, 1973). As defined by Spielberger (1973), the state anxiety subscale (STAIC-S) measures transitory anxiety states, while the trait anxiety subscale (STAIC-T) assesses relatively stable characteristics of anxiety. The STAIC-S subscale consists of 20 items that describe how respondents are *currently* feeling and these are rated utilising a 3-point scale (e.g., I feel: 1 = very calm; 2 = calm; 3 = not calm). The STAIC-T subscale comprises 20 short statements that describe how respondents *usually* feel (e.g., I worry about making mistakes, I am shy) to be rated on a 3-point scale (1 = hardly-ever, 2 = sometimes, 3 = often). Scores range from 20 to 60 on each respective subscale, with higher scores indicating higher levels of state or trait anxiety.

The reliability and validity of the STAIC has been supported by numerous studies with children (Kirisici & Clark, 1996). Good to excellent internal consistency reliability has been reported with Cronbach's alpha coefficients ranging from 0.71 to 0.76 for the STAIC-S subscale and 0.82 to 0.89 for the STAIC-T subscale (Papay & Spielberger, 1986). Spielberger (1973) has reported test-retest reliability as moderate for both subscales. The construct validity of the STAIC-S subscale has been demonstrated by Roberts, Vargo and Ferguson (1989), who found that STAIC-S scores were higher in anxiety provoking test conditions as opposed to baseline conditions. The concurrent validity of the STAIC-T subscale has been supported by high correlations with similar measures, for example, the Children's Manifest Anxiety Scale (CMAS) ($r = 0.75$; Castaneda, McCandless, & Palermo, 1956) and the General Anxiety Scale for Children (GASC) ($r = 0.63$; Saranson, Davidson, Lighthall, Waite, & Ruebush, 1960).

3.2.1.3.2 Dysphoria

The short version of the Children's Depression Inventory (CDI:S; Kovacs, 1992) was utilised to measure levels of dysphoria [*see Appendix B for a copy of the questionnaire*]. According to Kovacs (2003), this version is more suitable for use with a non-clinical population as it does not contain the suicide item that is featured in the full CDI. It has been found that the results of both versions are typically comparable (Kovacs, 2003). The CDI:S was developed for children and adolescents aged seven to seventeen years. It contains 10 items that quantify a range of symptoms, including depressed mood, difficulties in hedonic capacity, vegetative functions, low self-assessment, hopelessness and problems in interpersonal behaviours (Kovacs, 2003). For each item the child has three possible choices corresponding to three levels of symptomatology: 0 = absence of symptom; 1 = mild symptom; and 2 = definite symptom. For example, the choices from item 8 include: 'I do not feel alone'; 'I feel alone many times'; or 'I feel alone all the time'. Participants are required to select the sentence that best describes them in the past two weeks. Fifty percent of the items begin with the sentence that represents the greatest symptom severity and for the other half, the sequence of choices is reversed. Higher scores indicate higher levels of dysphoria, with scores ranging from 0 to 20.

Previous research has demonstrated that the CDI possesses adequate reliability and validity with respect to depressive symptoms (e.g., Kovacs, 1981; Weiss et al., 1991; Reynolds, 1994; Charman & Pervova, 2000). Good to excellent internal consistency

reliability has been reported for the 27-item CDI with Cronbach's alpha coefficients ranging from .71 to .87 (Kovacs, 1985). It has been found that the CDI:S correlates $r = .89$ with the full CDI and its alpha reliability coefficient has been reported at .80, signifying that it represents the overall content of the long CDI at an acceptable level (Kovacs, 2003). Giannakopoulos et al. (2009) have found that test-retest reliability ranges from moderate to high, depending on the time interval and the type of sample (i.e., clinical or general population). According to Kovacs (2003), "*The CDI has been utilized in hundreds of clinical and experimental research studies and its validity has been well established using a variety of techniques*" (p. 61). It has been demonstrated that CDI factor scores classify participants as depressed versus not depressed with a high degree of accuracy (Craighead, Curry, & Ilardi, 1995). The latter study also found that the CDI has a sensitivity of 80% and a specificity of 84%.

3.2.1.4 General Procedure

Participants were tested individually in a quiet area situated within the school grounds. School staff worked close by and the experimenter and child were always in view. First, the experimenter provided the participant with a brief explanation of the research (with the opportunity to withdraw) and presented the consent form. The experiment then consisted of the administration of the STAIC-S subscale (Spielberger, 1973), the non-emotive AB task, the administration of the CDI:S (Kovacs, 1992), the emotive AB task, and the administration of the STAIC-T subscale (Spielberger, 1973).

During the administration of the scales, the participant was asked whether they would like the experimenter to read each statement out loud to them and reply verbally and/or on paper or whether they were comfortable with reading the statements and answering on their own.

After the experiment, the participant was thanked for taking part and debriefed as to the purpose of the investigation. It was ensured that all participants understood the purpose of the project and they were then rewarded with a sticker for taking part. [*See Appendix C for example covering letters, briefing/debriefing material, and consent forms*].

3.2.1.5 Attentional Blink Task Procedure

Trials contained a rapid serial visual presentation (RSVP) stream of 20 stimuli comprising one or two target stimuli and 18 or 19 distracter stimuli, respectively. The AB

task consisted of one block of 10 practice trials and one block of 60 test trials. The practice block comprised two (20%) single target trials and eight (80%) double target trials; the test block consisted of 12 (20%) single target trials and 48 (80%) double target trials.

At the beginning of each trial, a small circle was presented for approximately 134 ms at the central fixation point. After this, on double target trials, the stimulus presentation events were as follows: an initial random sequence of distracter stimuli (either five or eight consecutive stimuli), the first target stimulus (T1), a further random sequence of distracter stimuli (either one, two, three or six consecutive stimuli), the second target stimulus (T2), and then the remaining random distracter stimuli (ranging from four to twelve consecutive stimuli) [see Figure 3.3].

After each RSVP stream, the participant was required to indicate each shape they had seen by simply matching it to an identical drawing on a response button. This style of responding was chosen since it reduces demands on mechanisms responsible for object and word detection (Visser et al., 2004). To begin with, participants were required to indicate the identity of the *first* shape viewed by pressing one of three buttons (i.e., a square, circle or triangle shaped button) situated on the *left* of the response pad. Children were then required to indicate the identity of the *last* shape viewed by pressing one of three buttons (i.e., a square, circle or triangle shaped button) situated on the *right* of the response pad. Participants had to press a blue button situated at the bottom of the response pad in order to continue to the next trial. If children only saw one shape, they were required to select which one it was by utilising the left set of buttons and then simply pressing the blue button. They were also asked to press the blue button if they had not seen any shapes.

For each double target trial, the T1 was always different to the T2, resulting in six possible combinations of trial: 1. Circle – Square; 2. Circle – Triangle; 3. Square – Circle; 4. Square – Triangle; 5. Triangle – Circle; 6. Triangle – Square. One, two, three, or six distracter stimuli were presented between the T1 and T2, corresponding to target stimuli being presented at Lag 2, Lag 3, Lag 4 and Lag 7. Note that, at least one distracter stimulus was included since the AB effect is rarely apparent when there are no distracter stimuli between the two target stimuli (this is called ‘Lag-1 sparing’) and there is evidence to suggest that different mechanisms are responsible for Lag-1 sparing and the AB effect (Chun & Potter, 1995; Hommel & Akyurek, 2005; Shapiro, Caldwell, & Sorensen, 1997). In addition, of the four lag conditions that were incorporated, two were within the typical blink time frame (i.e., Lag 2/3), one within the recovery period (i.e., Lag 4) and one outside of the blink time frame

(i.e., Lag 7) (Broadbent & Broadbent, 1987; Raymond et al., 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). That is, each of the four lag positions corresponded to a stimulus onset asynchrony (SOA) between the T1 and T2 of 268 ms (Lag 2), 402 ms (Lag 3), 536 ms (Lag 4), and 938 ms (Lag 7). There were 12 trials at each of the four lag positions, which comprised two trials for every T1-T2 trial type (i.e., Circle – Square; Circle – Triangle; Square – Circle; Square – Triangle; Triangle – Circle; Triangle – Square).

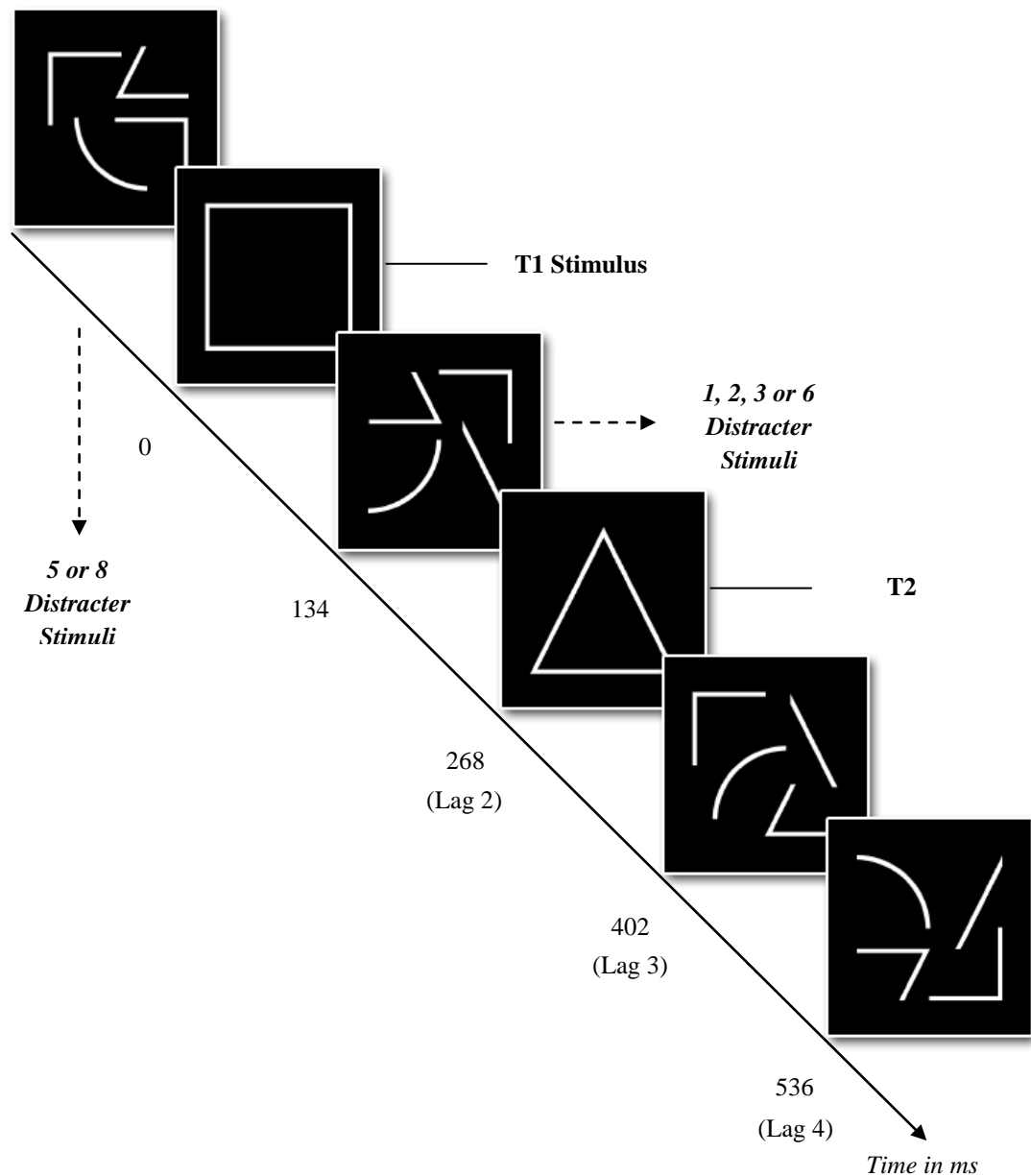


Figure 3.3 Example of a double-target trial in which the T1 was a square and the T2 was a triangle.

For each single target trial, the target stimulus appeared at serial position 8, 10, 12 or 16. Thus, the target stimulus appeared in one of the positions that the T2 had appeared in for each lag (i.e., 2, 3, 4 or 7) during the double target trials. Only two single target trials were presented in the practice block: a square and a circle, appearing in serial positions 8 and 16, respectively.

3.2.1.6 Data Analysis

Ten participants were excluded from the original data set ($N = 115$) due to non-completion of the task. A further six participants were excluded because they obtained a T-score of 65 or above on the CDI, which is generally considered the threshold for clinical significance (Kovacs, 2003). This was important since it is thought that anxiety and depression differ in respect to attentional allocation (e.g., see Mogg & Bradley, 2005). Six participants' data sets were then removed due to poor accuracy on double target trials (i.e., below two standard deviations of the sample mean). This resulted in a final sample of 93 participants (47 male, 46 female) aged between eight and eleven years ($M = 9.42$, $SD = .91$).

Responses to the STAIC questionnaire allowed participants to be divided into groups of high and low levels of anxiety utilising upper and lower tertiles, respectively. Mean ranking was applied in the case of ties. For the trait anxiety analysis, this resulted in a participant sample of 61 (30 male, 31 female; age range = 8-11 years, M age = 9.36, $SD = .95$), which consisted of 30 high trait anxious (HTA) (14 male, 16 female; age range = 8-11 years, M age = 9.20, $SD = .89$; M trait score = 43.47; $SD = 2.49$) and 31 low trait anxious (LTA) (16 male, 15 female; age range = 8-11 years, M age = 9.52, $SD = .99$; M trait score = 27.81; $SD = 3.50$) participants. An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(47.69) = -10.70$, $p < .001$].

For the state anxiety analysis, there was a total of 63 participants (27 male, 36 female; age range = 8-11 years; M age = 9.32, $SD = .95$), which consisted of 32 high state anxious (HSA) (16 male, 16 female; age range = 8-11 years, M age = 9.34, $SD = .94$; M state score = 32.25; $SD = 3.45$) and 31 low state anxious (LSA) (11 male, 20 female; age range = 8-11 years, M = 9.29, $SD = .97$; M state score = 23.42; $SD = 1.95$) participants. An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than did the LSA group [$t(39.57) = -12.50$, $p < .001$].

To investigate the effects of age on AB task performance, participants were divided into two groups depending on whether they were in Year 4 or Year 6. This resulted in a participant sample of 55 (26 male, 29 female; age range = 8-11 years, M age = 9.44, SD = 1.12), which consisted of 24 participants in Year 4 (12 male, 12 female; age range = 8-9 years, M age = 8.29, SD = .46) and 31 participants in Year 6 (14 male, 17 female; age range = 10-11 years, M age = 10.32, SD = .48).

3.2.2 Results

3.2.2.1 Attentional Blink Analysis

Initially, dual-target trial data were analysed from the entire participant sample (N = 93). A correct response comprised accurately identifying both the type (i.e., circle, square or triangle) and number of targets (i.e., two) in the RSVP stream. The overall percentage of correct responses was 77% (SD = 14%). Descriptive statistics demonstrated that participants performed worse at Lag 2 (M = 69%; SD = 18%) compared with later lags (i.e., Lag 3 [M = 78%; SD = 17%]; Lag 4 [M = 80%; SD = 16%]; Lag 7 [M = 78%; SD = 17%]).

To investigate whether there was an AB effect, a one-way repeated measures analysis of variance (ANOVA) of the percentage of correct responses was conducted with Lag (2, 3, 4, and 7) as the independent variable. Results revealed that there was a significant main effect for lag [$F(3, 276) = 21.52$, $p < .001$; $\eta_p^2 = .19$] [see Figure 3.4]. Pair-wise Bonferroni corrected comparisons revealed that participants performed significantly worse at Lag 2 compared with Lag 3 ($p < .001$; $d = 1.06$), Lag 4 ($p < .001$, $d = 0.65$), and Lag 7 ($p < .001$, $d = 1.06$), but Lags 3, 4 and 7 did not significantly differ from each other (all p 's $> .05$).

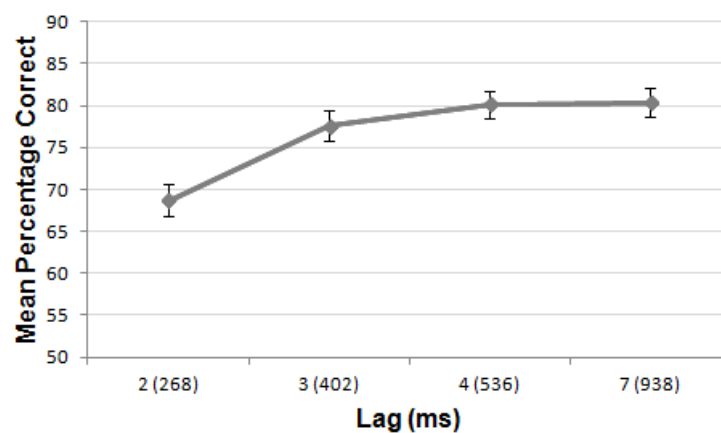


Figure 3.4 The mean percentage of correct responses for each lag. Error bars represent standard errors of the mean.

3.2.2.2 Effects of Age

To investigate the effects of age on AB task performance, a mixed ANOVA was carried out with Age (Year 4 [$N = 24$] versus Year 6 [$N = 31$]) as the independent between-groups variable and Lag (2, 3, 4, and 7) as the independent within-groups variable. There was a main effect for lag [$F(3, 159) = 11.99, p < .001; \eta_p^2 = .18$] but not for age [$F(1, 53) = 2.05, p = .158, \eta_p^2 = .04$]. Furthermore, the interaction between age and lag [$F(3, 159) = 1.06, p = .367; \eta_p^2 = .02$] did not reach statistical significance.

The main effect for lag remained the same to that reported in section 3.2.2.1.

3.2.2.3 Trait Anxiety Analysis

To investigate the effects of trait anxiety on the AB, a mixed ANOVA was carried out with Trait Anxiety (high [$N = 30$] versus low [$N = 31$]) as the independent between-groups variable and Lag (2, 3, 4, and 7) as the independent within-groups variable. There was a main effect for lag [$F(3, 177) = 12.32, p < .001; \eta_p^2 = .17$] but not for trait anxiety [$F(1, 59) = .301, p = .585, \eta_p^2 = .03$]. The interaction effect between trait anxiety and lag did not reach statistical significance [$F(3, 177) = .118, p = .949; \eta_p^2 = .00$].

The main effect for lag remained the same to that reported in section 3.2.2.1.

3.2.2.4 State Anxiety Analysis

To investigate the effects of state anxiety on the AB, a mixed ANOVA was carried out with State Anxiety (high [$N = 32$] versus low [$N = 31$]) as the independent between-groups variable and Lag (2, 3, 4, and 7) as the independent within-groups variable. There was a main effect for lag [$F(3, 183) = 12.59, p < .001; \eta_p^2 = .17$] but not for state anxiety [$F(1, 61) = .01, p = .936; \eta_p^2 = .00$]. The interaction effect between state anxiety and lag did not reach statistical significance [$F(3, 183) = 1.27, p = .286; \eta_p^2 = .02$].

The main effect for lag remained the same to that reported in section 3.2.2.1.

3.2.3 Discussion

The main aim of the present investigation was to determine whether children are subject to the same processing constraints as adults. That is, to establish whether children also display an AB effect due to decreased ability to process targets presented within approximately 200-400 ms of each other. Further aims involved determining whether age or

anxiety level affected the ability to temporally process consecutively presented non-emotive stimuli amongst eight to eleven year olds.

Findings revealed that participants were significantly worse at detecting both targets in an RSVP paradigm when the T2 appeared at the second lag, that is, 268 ms after the T1. Furthermore, participants' performance significantly improved when the T2 appeared within Lags 3 to 7 (i.e., 402 ms to 938 ms) of the T1. These results support hypothesis i) [*see section 3.1*] and are consistent with adult studies, which demonstrate that such individuals are less able to correctly identify a T2 when it appears within 200-400 ms of a T1 (Broadbent & Broadbent, 1987; Raymond et al., 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). As such, it is reasonable to presume that children aged eight to eleven years are subject to the same processing limits as adults. This is important since it has been found that processing speed significantly varies between childhood and adolescence (see Kail, 1991; Ridderinkhof & van der Stelt, 2000, for reviews), suggesting that not all children are able to process consecutively presented stimuli at the same rate as adults (Crocker & Maratos, 2011).

In relation to this, findings were observed even when age was taken into consideration. That is, there was no difference in performance between children in Year 4 compared with Year 6. This does not support hypothesis ii) and is important given that processing ability has previously been found to vary depending on a child's specific age group (e.g., Garrad-Cole et al., 2011; Heim et al., 2011). That said, a limitation of these past studies is that they did not include eight to nine year olds when comparing ages between seven and fifteen years. Consequently, this research was unable to determine whether children of these ages are able to process consecutively presented stimuli at the same rate as adults. An advantage of the current study is that it extends this research by demonstrating that those in Year 4, which includes eight to nine year olds, do in fact display similar processing constraints as adults. This is in accordance with Crocker and Maratos (2011), who found that only children aged eight years or older could reliably identify the absence or presence of target stimuli when presenting one item every 100 ms. However, the present study extends their research by employing an AB as opposed to an RSVP task. Therefore, it is possible to conduct further RSVP/AB tasks with children aged eight years and above utilising the same methodology employed with adult samples. The study by Crocker and Maratos (2011) included facial stimuli and thus, the present research demonstrates that other stimulus sets can

be incorporated to successfully investigate temporal attention in an AB task with eight to eleven year olds.

In relation to anxiety, findings demonstrated that the AB profile was not affected by levels of state or trait anxiety. This was expected [*see hypothesis iii), section 3.1*] given that the stimuli consisted of non-emotive geometric shapes. Although previous AB studies have been undertaken with both atypically and typically developing child populations (Facoetti et al., 2008; Lallier et al., 2010; Mason et al., 2005; McLean et al., 2010; Ray Li et al., 2004; Rinehart et al., 2010; Visser et al., 2004), it appears that the current study represents a first attempt to investigate the effects of *anxiety* on the AB in children.

In sum, the present study demonstrated that children aged eight to eleven years display an AB profile for non-emotive stimuli typical to that of adolescents and adults. This suggests that this AB task (and others utilising different pictorial stimuli/lags) can be employed in future experiments of temporal attention in both atypically and typically developing children. Findings also suggest that age and levels of anxiety do not affect performance in a non-emotive AB task. As such, the subsequent study will investigate temporal attentional bias to *emotive* stimuli in high and low anxious children utilising the AB task.

3.3 Investigation Two: Facilitated Engagement towards Emotive Stimuli during the Attentional Blink Task

As stated in the Introduction [*see section 3.1*], the main aim of Investigation Two was to determine whether like adults, children with high levels of anxiety demonstrate facilitated engagement for angry, relative to positive and neutral faces.

3.3.1 Methods

3.3.1.1 Participants

The same children that took part in the previous investigation [*see section 3.2*] also participated in the current investigation. However, 14 of these children did not complete the emotive AB task due to fatigue. Thus, participants consisted of 101 children (51 male; 50 female) aged between eight and eleven years ($M = 9.40$, $SD = .91$). These were recruited from three participating primary schools situated in the East Midlands, United Kingdom.

Each school received £50 worth of book vouchers for taking part. The selection criteria were: i) normal or corrected-to-normal vision; ii) English as the first language; and iii) being free from developmental disorders and learning disabilities, based on teachers' judgments. Ethical approval was obtained from the University of Derby Psychology Research Ethics Committee.

3.3.1.2 Stimuli

Four schematic faces were incorporated as the target stimuli in the experiment: a threatening face; a positive face; and two neutral faces (N1 and N2) [see Figure 3.5]. Three of these faces (i.e., threatening, positive and N1) were the same as those utilised by Öhman et al. (2001). The threatening face was their “angry” prototype and will thus be referred to as such in the present investigation. The positive face was their “friendly” prototype, however, it has also been described as “happy” (Calvo & Esteves, 2005). Thus, the present study will refer to this stimulus type as positive. A second, non-identical neutral face was utilised in order to reduce potential effects of repetition blindness (i.e., decreased ability to detect the second of two identical targets in an RSVP stream; Kanwisher, 1987). All four faces have previously been utilised in a study by Maratos et al. (2008; and also Maratos, 2011). Each of the facial stimuli differed with respect to the shape of three key features: the eyebrows, eyes and mouth (e.g., when comparing the angry and positive faces, the eyebrows, eyes and mouth were inverted).

[Content removed for copyright reasons]

Figure 3.5 The schematic facial stimuli utilised displaying angry, positive and neutral (N1 and N2, respectively) facial expressions. The angry, positive, and neutral N1 faces were adapted from “The face in the crowd revisited: A threat advantage with schematic stimuli,” by A. Öhman, D. Lundqvist, and F. Esteves, 2001, *Journal of Personality and Social Psychology*, 80, pp. 381-396. Copyright 2001 by the American Psychological Association. The neutral N2 face was adapted from “Identification of Angry Faces in the Attentional Blink,” by F. A. Maratos, K. Mogg, and B. P. Bradley, 2008, *Cognition and Emotion*, 00, pp. 1-13. Copyright 2008 by Psychology Press.

Thirty different distracter stimuli were included as well, which comprised the main features of each facial stimulus set in random positions and orientations [see Figure 3.6 for examples]. Stimuli were presented in the same way as described earlier for the control study, that is, utilising Inquisit™ (by Millisecond Software™) to present one stimulus approximately every 134 ms [see Chapter 3, section 3.2.1.2]. Each face measured ~6.5 X 7.7 cm and subtended visual angles of ~9.30 X 11 degrees when presented on the screen.

[Content removed for copyright reasons]

Figure 3.6 Examples of the distracter stimuli utilised. Adapted from “Identification of Angry Faces in the Attentional Blink,” by F. A. Maratos, K. Mogg, and B. P. Bradley, 2008, *Cognition and Emotion*, 00, pp. 1-13. Copyright 2008 by Psychology Press.

3.3.1.3 General Procedure

The general procedure followed was as in the previous investigation [see section 3.2.1.4].

3.3.1.4 Attentional Blink Task Procedure

As in the control AB study [see section 3.2.1.5], all trials contained an RSVP stream of 20 stimuli comprising one or two target stimuli and 18 or 19 distracter stimuli, respectively. The main AB task consisted of one block of 10 practice trials and two blocks of 60 test trials (i.e., 120 test trials in total, which were presented in a single session). Each participant was allowed a short break after having completed the first block of test trials. The practice block comprised two (20%) single target (i.e., one target stimulus) trials and eight (80%) double target (i.e., two target stimuli) trials. Test trials comprised double target trials only, since the aim of the study was to assess the AB. Single target trials were included in the practice block to ensure that participants did not assume that the test trials included double target trials only.

At the beginning of each trial, a small circle was presented for approximately 134 ms at the central fixation point. After this, on double target trials, the stimulus presentation

events were as follows: an initial random sequence of distracter stimuli (either five or eight consecutive stimuli), the T1, a further random sequence of distracter stimuli (either one, two, three or six consecutive stimuli), the T2, and then the remaining random distracter stimuli (ranging from four to twelve consecutive stimuli) [see Figure 3.7]. Thus, the trial events were as in the previous investigation [see section 3.2.1.5]. That is, the T2 was presented at Lag 2, Lag 3, Lag 4, and Lag 7 (268 ms, 402 ms, 536 ms, and 938 ms, respectively).

After each RSVP stream, the participant was required to make two consecutive responses utilising a Cedrus RB-830 response pad. To indicate which face had been viewed, they were required to simply match the viewed face to an identical drawing on a response pad button. For the participant's first response, they were required to indicate the emotional expression of the *first* face viewed. This was achieved by pressing one of three buttons situated on the *left* of the response pad (an angry face, a positive face or a neutral face to indicate whether the first face seen was angry, positive or neutral). The participant was then required to indicate the emotional expression of the *last* face viewed by pressing one of three buttons (angry, positive or neutral) situated on the *right* of the response pad. The participant had to press a blue button situated at the bottom of the response pad in order to continue to the next trial. If only one face was viewed, they were required to select which one it was by utilising the left set of buttons and then pressing the blue button. They were also required to press the blue button if they had not seen any faces.

For each double target trial, the T1 was always a neutral face (either N1 or N2), and the T2 was an angry, positive or neutral face. This resulted in three types of trial, which depended on the emotional expression displayed as the T2:

- i) Neutral T1 – Angry T2 (threatening trials)
- ii) Neutral T1 – Positive T2 (positive trials)
- iii) Neutral T1 – Neutral T2 (neutral trials)

During each trial, the T1 was always different to the T2; thus, if the T1 was N1, the T2 was N2, or vice-versa. In an attempt to ensure that participants did not assume that all the T1 stimuli were neutral in the test trials, two valences were included in the practice block: i) Angry T1 – Neutral T2 (two threatening trials); and ii) Positive T1 – Neutral T2 (two positive trials). There were 30 trials at each lag position (i.e., Lags 2, 3, 4, and 7), which comprised ten trials for every T1–T2 valence (i.e., threatening, positive, and neutral trials).

The single target trials were the same as the double target trials, with the exception that only one target stimulus was presented (i.e., the T1 was replaced with a distracter

stimulus). Only two single target trials were presented in the practice block (but not in the test trials): an angry face and a positive face, appearing in serial positions 8 and 16, respectively.

[Content removed for copyright reasons]

Figure 3.7 Example of a double-target trial in which the T1 was a neutral face and the T2 was an angry face. Adapted from “Identification of Angry Faces in the Attentional Blink,” by F. A. Maratos, K. Mogg, and B. P. Bradley, 2008, *Cognition and Emotion*, 00, p. 5. Copyright 2008 by Psychology Press.

3.3.1.5 Data Analysis

Thirteen participants were excluded from data analysis due to non-completion of the AB task. A further five participants were excluded because they obtained a T-score of 65 or above on the CDI, which is generally considered the threshold for clinical significance (Kovacs, 2003). Seven participants' data sets were then removed due to poor accuracy in identifying both targets (i.e., below 1.5 standard deviations of the sample mean). This resulted in a final sample of 75 participants (35 male, 40 female) aged between eight and eleven years ($M = 9.41$, $SD = .90$).

Responses to the STAIC questionnaire allowed participants to be divided into groups of high and low levels of anxiety utilising upper and lower tertiles, respectively. Mean ranking was applied in the case of ties. This resulted in a participant sample of 50 (23 male, 27 female; age range = 8-11 years, M age = 9.34, $SD = .50$) for the trait anxiety analysis. This sample consisted of 24 HTA (10 male, 14 female; age range = 8-11 years, M age = 9.04, $SD = .81$; M trait score = 43.29, $SD = 1.94$) and 26 LTA (13 male, 13 female; age range = 8-11 years, M age = 9.62, $SD = .94$; M trait score = 27.27, $SD = 3.44$) participants. An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(40.11) = -20.49$, $p < .001$].

For the state anxiety analysis, there was a total of 48 participants (20 male, 28 female; age range = 8-11 years; M age = 9.25, $SD = .50$). This sample consisted of 26 HSA (13 male, 13 female; age range = 8-11 years, M age = 9.31, $SD = .88$; M state score = 31.96, $SD = 3.26$) and 22 LSA (7 male, 15 female; age range = 8-11 years, M age = 9.18, $SD = .96$; M state score = 22.50, $SD = 1.47$) participants. An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than the LSA group [$t(46) = -12.57$, $p < .001$].

3.3.2 Results

3.3.2.1 Attentional Blink Analysis

Data were first analysed from the entire participant sample ($N = 75$). A correct response comprised accurately identifying both the type (i.e., angry, positive and/or neutral) and number of targets (i.e., two) in the RSVP stream. The mean overall percentage of correct responses was 30% ($SD = 16\%$). Table 3.1 shows the mean percentage of correct responses as a function of lag and valence.

Table 3.1

Mean Percentage of Correct Responses as a Function of Lag and Valence (with Standard Deviations in Parentheses)

	Lag 2	Lag 3	Lag 4	Lag 7	Total
Threatening	35 (23)	41 (23)	38 (24)	43 (24)	39 (20)
Positive	35 (23)	38 (25)	39 (24)	40 (23)	38 (20)
Neutral	9 (14)	12 (18)	13 (17)	20 (21)	14 (15)
Total	26 (16)	30 (17)	30 (18)	34 (19)	

To investigate the effects of emotive stimuli on the AB, a repeated measures ANOVA of correct responses was carried out with Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent variables. Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 14.37, p = .001$] and thus degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .87$). Results revealed that there were main effects for both lag [$F(3, 222) = 12.33, p < .001, \eta_p^2 = .14$] and valence [$F(1.73, 128.20) = 114.28, p < .001, \eta_p^2 = .61$]. The interaction effect between lag and valence did not reach statistical significance [$F(6, 444) = 1.56, p = .156, \eta_p^2 = .02$].

For the main effect of lag, pair-wise Bonferroni corrected comparisons demonstrated that participants performed worse on trials at Lag 2 ($M = 26\%$) compared with Lag 3 ($M = 30\%; p = .016; d = .24$), Lag 4 ($M = 30\%; p = .026; d = .24$), and Lag 7 ($M = 34\%; p < .001; d = .46$). Participants also performed worse on trials at Lag 3 and Lag 4 compared with Lag 7 ($p = .010; d = .22$ and $p < .015; d = .22$, respectively) [see Figure 3.8].

For the main effect of valence, pair-wise Bonferroni corrected comparisons revealed worse performance on trials with neutral faces ($M = 14\%$) compared with angry ($M = 39\%; p < .001; d = .94$) and positive faces ($M = 38\%; p < .001; d = .92$) [see Figure 3.9].

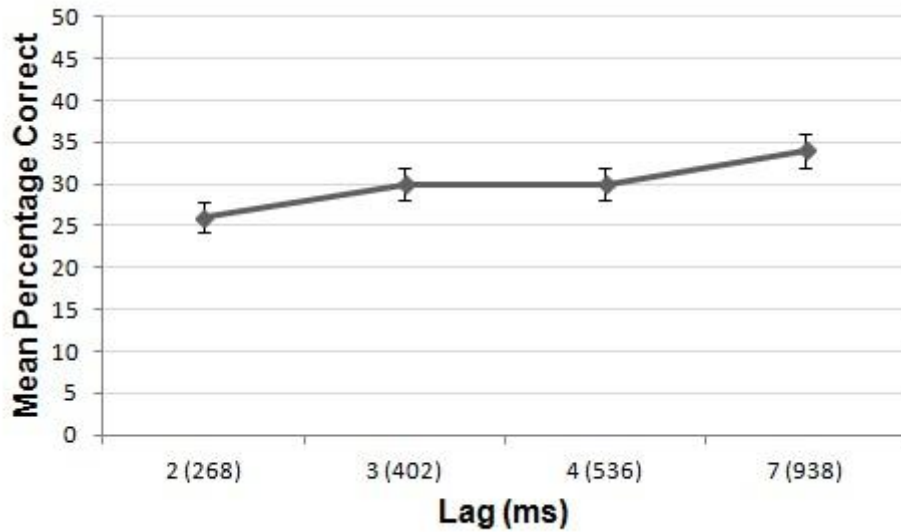


Figure 3.8 The mean percentage of correct responses for each lag. Error bars represent standard errors of the mean.

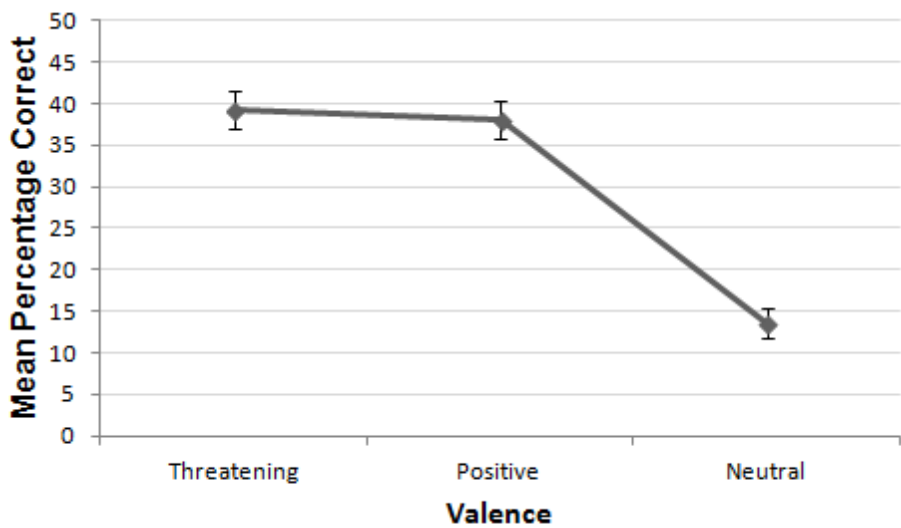


Figure 3.9 The mean percentage of correct responses for each valence. Error bars represent standard errors of the mean.

3.3.2.2 Trait Anxiety Analysis

Data were analysed from participants in high and low trait anxiety groups ($N = 50$) [see section 3.3.1.5 for descriptive statistics]. The mean overall percentage of correct responses was 31% ($SD = 15\%$). For HTA participants, the mean overall percentage of correct responses was 32% ($SD = 16\%$); for LTA participants it was 29% ($SD = 15\%$).

To investigate the effects of trait anxiety and/or emotive stimuli on the AB, a mixed ANOVA was conducted with Trait Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 11.87, p = .003$] and as such, degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .86$).

Results revealed that there were main effects for lag [$F(3, 144) = 9.32, p < .001; \eta_p^2 = .16$] and valence [$F(1.72, 82.56) = 77.31, p < .001; \eta_p^2 = .62$] but not trait anxiety [$F(1, 48) = .44, p = .512; \eta_p^2 = .01$]. The interaction effects between trait anxiety and lag [$F(3, 144) = 2.38, p = .072; \eta_p^2 = .05$], trait anxiety and valence [$F(1.72, 82.56) = .215, p = .774; \eta_p^2 = .00$], lag and valence [$F(5.78, 277.47) = .72, p = .628; \eta_p^2 = .02$] and trait anxiety, lag and valence [$F(5.78, 227.47) = .170, p = .983; \eta_p^2 = .00$] did not reach statistical significance.

The main effects for lag and valence remained similar to those reported in section 3.3.2.1.

3.3.2.3 State Anxiety Analysis

Data were analysed from participants in the high and low state anxiety groups ($N = 48$) [see section 4.2.5 for descriptive statistics]. The mean overall percentage of correct responses was 28% ($SD = 14\%$). For HSA participants, the mean overall percentage of correct responses was 27% ($SD = 14\%$); for LSA participants it was 29% ($SD = 14\%$).

To investigate the effects of state anxiety and/or emotive stimuli on the AB, a mixed ANOVA was conducted with State Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 7.42, p = .024$] and as such, degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .92$). Results revealed that there were main effects for lag [$F(3, 138) = 8.71, p < .001, \eta_p^2 = .16$] and valence [$F(1.84, 84.52) = 66.35, p < .001, \eta_p^2 = .59$] but not state anxiety [$F(1, 46) = .18, p = .677, \eta_p^2 = .00$]. There were no statistically significant interaction effects between state anxiety and lag [$F(3, 138) = .70, p = .553, \eta_p^2 = .02$], state anxiety and valence [$F(1.84, 84.52) = .33, p = .699, \eta_p^2 = .01$], lag and valence [$F(6, 276) = 1.40, p = .216, \eta_p^2 = .03$], nor state anxiety, lag and valence [$F(6, 276) = 1.04, p = .398, \eta_p^2 = .02$].

The main effects for lag and valence remained similar to those reported in section 3.3.2.1.

3.3.2.4 Task Difficulty

Given that the mean overall percentage of correct responses (i.e., 30%) was substantially lower than is usual (i.e., approximately 70%), it was important to assess the difficulty of the task. In order to achieve this, paired samples t-tests were conducted for Lags 2 and 7 in both the current emotive AB investigation and the previous control (non-emotive) AB study [see section 3.2]. Prior to analysis, it was ensured that both data sets were comparable by: i) excluding participants who did not successfully complete both tasks; and ii) excluding participants who performed poorly in either of the two tasks (i.e., below 1.5 standard deviations of the sample mean in the affective task; below 2 standard deviations of the sample mean in the control task). This resulted in a sample of 68 participants (31 male, 37 female) aged eight to eleven years ($M = 9.46$, $SD = .89$), all of whom had taken part in both investigations.

Firstly, a paired samples t-test was conducted to compare emotive task performance with control task performance at Lag 2. It was found that participants performed significantly worse at Lag 2 during the emotive task ($M = 27$, $SD = 16$) compared with the control task [$M = 71$, $SD = 18$; $t(67) = 17.84$, $p < .001$; $d = 2.59$]. A paired samples t-test was then conducted to compare emotive task performance with control task performance for Lag 7. Participants additionally performed significantly worse at Lag 7 during the emotive task ($M = 35$, $SD = 19$) compared with the control task [$M = 83$, $SD = 16$; $t(67) = 20.20$, $p < .001$; $d = 2.74$].

3.3.2.5 Effects of Age

Finally, in an exploratory analysis, the effects of age on affective AB task performance were investigated. Here, a mixed ANOVA was carried out with Age (Year 4 versus Year 6) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. This resulted in a participant sample of 42 (19 male, 23 female; age range = 8-11 years, $M = 9.45$, $SD = .13$). This sample consisted of 18 Year 4 (8 male, 10 female; age range = 8-9 years, $M = 8.28$, $SD = .46$) and 24 Year 6 (11 male, 13 female; age range = 10-11 years, $M = 10.33$, $SD = .48$) participants.

Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 6.82, p = .033$] and as such, degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .92$). Results revealed that there were main effects for lag [$F(3, 120) = 11.70, p < .001, \eta_p^2 = .23$] and valence [$F(1.84, 73.56) = 71.09, p < .001, \eta_p^2 = .64$] but not year [$F(1, 40) = .12, p = .746, \eta_p^2 = .00$]. There were no statistically significant interaction effects between year and lag [$F(3, 120) = .41, p = .747, \eta_p^2 = .01$], year and valence [$F(1.84, 73.56) = 2.16, p = .126, \eta_p^2 = .05$], lag and valence [$F(5.92, 236.67) = .74, p = .620, \eta_p^2 = .02$], nor year, lag and valence [$F(5.92, 236.67) = 56, p = .759, \eta_p^2 = .01$].

The main effects for lag and valence remained similar to those reported in section 3.3.2.1.

3.3.3 Discussion

Results from the present investigation support hypothesis iv) [see section 3.1] since they revealed that eight to eleven year old children were significantly worse at detecting both targets in an RSVP stream when the T2 appeared at the second lag, that is, 268 ms after the T1. In addition, children's performance did not significantly improve until the T2 appeared at Lag 7, that is, 938 ms after the T1. These findings are similar to those of Investigation One and suggest that children display an AB effect typical to that of adults (see Broadbent & Broadbent, 1987; Raymond et al., 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987).

The main aim of this investigation, however, was to determine whether children display an attenuated AB for emotive, particularly threatening, stimuli, and more importantly, whether this effect is moderated by anxiety level. Findings demonstrated that there was no attentional bias for threat in relation to anxiety. That is, high anxious children did not attend to and process the angry faces to a greater extent than low anxious children. This finding was unexpected [see hypothesis vi), section 3.1] and is in contrast to much of the published research on adults (Arend & Botella, 2002; Barnard et al., 2005; D'Alessandro et al., 2009; Fox et al., 2005; Reinecke et al., 2008; Trippe et al., 2007; Vaquero et al., 2006).

Results demonstrated that there was an effect of valence on task performance and that this did not depend on the lag between the T1 and the T2. More specifically, children performed better on trials in which the T2 was an angry or positive, compared with a neutral, face throughout the AB task. This was irrespective of state or trait anxiety status (i.e., high

versus low) and age group (i.e., Year 4 versus Year 6). This finding of an emotion-superiority effect is in line with hypothesis v) stated in section 3.1 and accords with previous adult data concerning the AB task and emotion superiority; namely, the research of de Jong and colleagues (de Jong et al., 2009; de Jong & Martens, 2007). In this research, it was found that the AB effect was reduced when the T2 appeared as an emotive (i.e., angry or happy), relative to a neutral, face and that this was irrespective of social anxiety status. This finding is consistent with the argument that the efficient processing of emotive facial expressions plays a fundamental role in interpersonal communication by providing non-verbal communication cues about behaviour (e.g., Goffman, 1967).

However, a further analysis revealed that the above investigation was confounded by task difficulty, since participants' performance was significantly poorer compared with the previous control AB study. This was irrespective of whether the target stimuli appeared within (i.e., 200-400 ms) or outside of the typical blink period (i.e., over 500 ms).

To sum, Investigation Two did not reveal any differences in children's processing of emotive stimuli in relation to anxiety. Instead, it was shown that all children demonstrated an emotion superiority effect, that is, performance was better on both angry and positive face trials compared with neutral face trials throughout the AB task. This was irrespective of state or trait anxiety status (i.e., high versus low) and age group (i.e., Year 4 versus Year 6). However, findings also demonstrated that this experiment was confounded by task difficulty. As such, it is necessary to conduct a further investigation into anxiety and the AB utilising a simplified version of the AB task, which is the purpose of Investigation Three.

CHAPTER 4

Investigation Three: Facilitated Engagement towards Emotive Stimuli during a Simplified Version of the Attentional Blink Task

The investigation reported in this chapter is conceptually similar to Investigation Two [see Chapter 3, section 3.3], however, it involved utilising a simplified version of the attentional blink task. It is reported in a separate chapter given that the participant sample differed to that included in the previous two investigations.

4.1 Introduction

Findings from the control study of the attentional blink (AB) with non-emotive stimuli [see Chapter 3, section 3.2] demonstrated that eight to eleven year old children were significantly poorer at detecting two targets in a rapid serial visual presentation (RSVP) paradigm when the second target (T2) appeared at Lag 2, that is, 268 milliseconds (ms) after the first target (T1). In contrast, performance significantly improved when the T2 appeared at Lag 3, 4 or 7; that is, approximately 402, 536 or 938 ms after the T1. This finding, which was not influenced by specific age or anxiety level, suggests that children between eight and eleven years of age produce a typical AB effect and thus, are subject to the same temporal attentional processing constraints as adults (Broadbent & Broadbent, 1987; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). This initial investigation was subsequently advanced by examining the effects of anxiety on temporal attention for *emotive* stimuli. Findings from this second investigation (Investigation 2; see Chapter 3, section 3.3) appeared to demonstrate that all children were better at detecting both angry and positive faces compared with neutral faces throughout the AB task. That is, children displayed facilitated engagement of attention for emotive faces per se. This was independent of state or trait anxiety status (i.e., high versus low) and age group (i.e., Year 4 versus Year 6). However, it was also determined that these findings were confounded by task difficulty. As such, the present study involved conducting further research into the effects of anxiety on the AB utilising a simplified version of the task.

As mentioned in Chapter 3, section 3.1, the magnitude of the AB can be affected by both the emotive content of the T2 stimulus and the affective disposition of the individual. For instance, studies investigating emotional saliency utilising word (Anderson, 2005; Anderson & Phelps, 2001; Kihara, & Osaka, 2008; Ogawa & Suzuki, 2004; Raymond et al., 1992; Shapiro, Arnell, & Raymond, 1997) and facial (de Jong, Koster, van Wees, & Martens, 2009; Maratos, Mogg, & Bradley, 2008; Milders, Sahraie, Logan, & Donnellon, 2006) stimuli as the T2 have demonstrated that the AB is attenuated when this stimulus appears as threatening, relative to neutral and/or positive. The finding that an angry face ‘breaks through’ the AB accords well with both cognitive and neural models of emotion, which typically assume that attentional resources are preferentially assigned to threatening, relative to non-threatening, information (e.g., Davis & Whalen, 2001; LeDoux, 1996; Mogg & Bradley, 1998; Öhman, 1996; Pessoa, 2005). This is often referred to as the ‘anger-superiority effect’ (de Jong et al., 2009). However, as outlined in Chapter 3, section 3.1, recent AB studies have also provided evidence of a ‘happiness-superiority’ effect (Miyazawa & Iwasaki, 2010; Srivastava & Srinivasan, 2010) or an ‘emotion-superiority’ effect per se (de Jong & Martens, 2007; de Jong et al., 2009).

In relation to anxiety, only a small number of studies have demonstrated that the AB is particularly attenuated for high anxious individuals compared with controls when the T2 stimulus appears as threatening (Arend & Botella, 2002; Barnard, Ramponi, Battye, & Mackintosh, 2005; D’Alessandro, Gemignani, Castellani, & Sebastiani, 2009; Fox, Russo, & Georgiou, 2005; Reinecke, Rinck, & Becker, 2008; Trippe, Hewig, Heydel, Hecht, & Miltner, 2007; Vaquero, Frese, Lupianez, Megias, & Acosta, 2006). However, such studies have tended to incorporate typographical stimuli and as such, they are limited in theoretical interpretation (Anderson, 2005; see Chapter 2, section 2.4 and Chapter 3, section 3.1 for further discussion). One study that has incorporated facial stimuli is that of Fox and colleagues (2005; see Chapter 3, section 3.1). To recap, this showed that the AB effect was apparent for both happy and fearful faces in low trait anxious individuals but significantly reduced and shorter in duration for fearful faces in high trait anxious individuals. However, there were limitations to this study, including that: i) target items differed categorically, thus introducing an additional component of task switching; and ii) it utilised fearful faces as the threatening stimulus, which are said to be less directly threatening than angry faces and consequently less efficient at capturing visual attention (Bannerman, Milders, de Gelder, & Sahraie, 2009; see Chapter 2, section 2.6 for further discussion).

As in Investigation Two, the main aim of the present investigation was to determine whether children with high levels of anxiety demonstrate facilitated engagement for angry, relative to positive and neutral faces. Again, this was achieved by presenting participants with an AB task in which the emotive content of the T2 was manipulated. However, the present investigation involved utilising a simplified version of the emotive AB task. Research has demonstrated that increased categorical or perceptual similarity between distracters and targets results in a more severe AB effect and hence, a lower mean percentage of correct responses (Chun & Potter, 1995; Maki, Bussard, Lopez, & Digby, 2003; Shapiro, Raymond, & Arnell, 1994). As such, in Investigation Three, two facial features were removed from the distracter stimuli in order to decrease perceptual similarities between the distracters and targets and simplify the AB task.

Based on findings from both Investigations One and Two, and previous research, it was hypothesised that all children would: i) display an AB effect of increased magnitude at earlier lags (i.e., Lags 2 to 3; approximately 200 to 400 ms) compared with later lags (i.e., Lag 4 and over; over approximately 400 ms); and ii) display an attenuated AB for emotive, relative to neutral, faces. It was further predicted that iii) high state and/or trait anxiety would be associated with an attenuated AB effect for angry, relative to positive and neutral, faces. That is, high anxious children would display an enhanced threat-superiority effect.

4.2 Methods

4.2.1 Pre-selection

A total of 183 children (93 male; 90 female) aged eight to eleven years ($M = 9.61$, $SD = .93$) were recruited from a primary school located in Derbyshire, United Kingdom. The school received £50 worth of book vouchers for taking part. This time, participants undertook an initial pre-selection process, which involved completing the trait anxiety subscale of the State-Trait Anxiety Inventory for Children (STAIC-T; Spielberger, 1973) and the short version of the Children's Depression Inventory (CDI:S; Kovacs, 1992) [see Chapter 3, section 3.2.1.3.2 for descriptions]. Responses to the STAIC-T questionnaire were then utilised to assign participants to groups of high and low levels of trait anxiety via the tertile split method. This resulted in approximately one third of the participants (i.e., those with medium levels of anxiety) being excluded. Mean ranking was utilised in the case of ties. In

addition, participants who obtained a T-score of 65 or above on the CDI:S were deemed to be highly dysphoric and were subsequently excluded.

4.2.2 Final Participants

Pre-selection resulted in a possible sample of 98 participants who were invited to take part in the experiment based on the following selection criteria: i) normal or corrected-to-normal vision; ii) English as the first language; and iii) free from developmental disorders and learning disabilities, as reported by teachers. Of those participants meeting the selection criteria, informed, written consent was obtained separately from parents/guardians and children before the experiment commenced. The final sample included 53 participants (29 male, 24 female) aged between eight and eleven years ($M = 9.49$, $SD = .89$). Ethical approval was again obtained for this investigation from the University of Derby Psychology Research Ethics Committee. [See Appendix C for example covering letters, briefing/debriefing material, and consent forms].

4.2.3 Stimuli

Target stimuli were identical to those incorporated in the previous investigation [see Chapter 3, section 3.3.1.2 and Figure 3.5]. However, distracters were simplified by halving the number of features in each [see Figure 4.1]. This resulted in distracters containing just two features, thus making them appear less perceptually similar to the targets.

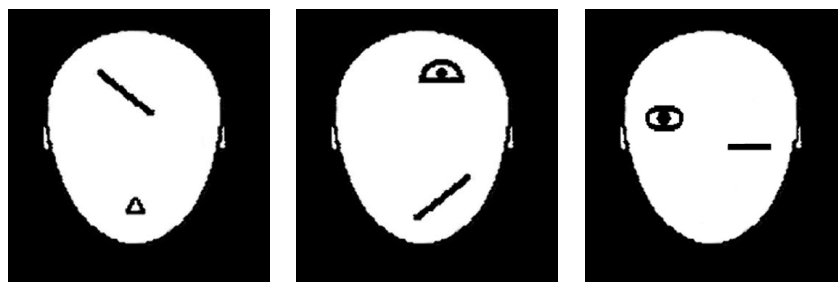


Figure 4.1 Examples of the distracter stimuli utilised.

4.2.4 Procedure

The general procedure was as in the preceding two investigations [see Chapter 3, section 3.2.1.4] with the exception that only the state subscale of the STAI-C was administered, which took place prior to attentional blink (AB) task commencement. Note that

trait data was not collected again given that the interval between pre-selection and study participation occurred within a twelve week time-frame. The AB task procedure was identical to that of Investigation Two [see Chapter 3, section 3.3.1.4] and the first target (T1) was always neutral whilst the second target (T2) was always emotive.

4.2.5 Data Analysis

One participant's data set was removed due to poor accuracy in identifying both targets (i.e., below two standard deviations of the sample mean). This resulted in a final participant sample of 52 children (28 male; 24 female) aged eight to eleven years ($M = 9.5$, $SD = .90$). These were 26 high trait anxious (HTA) (10 male, 16 female; age range = 8-11 years, M age = 9.58, $SD = .81$; M trait score = 45.12, $SD = 3.02$) and 26 low trait anxious (LTA) (18 male, 8 female; age range = 8-11 years, M age = 9.42, $SD = .99$; M trait score = 23.96, $SD = 3.45$) children. An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(50) = -23.52$, $p < .001$].

For the purpose of the state anxiety analysis, participants were assigned to groups of high and low levels of state anxiety based upon responses on the state anxiety subscale of the STAIC (STAIC-S; Spielberger, 1973). This resulted in 25 high state anxious (HSA) (13 male, 12 female; age range = 8-11 years, M age = 9.44, $SD = .82$; M state score = 30.32, $SD = 3.63$) and 27 low state anxious (LSA) (15 male, 12 female; age range = 8-11 years, M age = 9.56, $SD = .97$; M state score = 22.59, $SD = 2.02$) children. An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than the LSA group [$t(50) = -9.58$, $p < .001$].

4.3 Results

4.3.1 Attentional Blink Analysis

Initially, data were analysed from the entire participant sample ($N = 52$). As before, a correct response comprised accurately identifying both the type (i.e., angry, positive or neutral) and number of targets (i.e., two) in the rapid serial visual presentation (RSVP) stream. The mean overall percentage of correct responses was 51% ($SD = 23\%$). Table 4.1 shows the mean percentage of correct responses as a function of lag and valence.

Table 4.1

Mean Percentage of Correct Responses as a Function of Lag and Valence (with Standard Deviations in Parentheses)

	Lag 2	Lag 3	Lag 4	Lag 7	Total
Threatening	58 (29)	60 (25)	60 (25)	62 (27)	60 (24)
Positive	52 (28)	54 (26)	57 (24)	58 (26)	55 (23)
Neutral	35 (30)	38 (32)	39 (31)	42 (30)	39 (29)
Total	48 (25)	51 (24)	52 (23)	54 (25)	

To investigate the effects of emotive stimuli on the AB, a repeated measures analysis of variance (ANOVA) of the percentage of correct responses was carried out with Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent variables. Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 14.96, p = .001$]. Thus, degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .82$). Results revealed that there were main effects for both lag [$F(3, 153) = 4.40, p = .005, \eta_p^2 = .08$] and valence [$F(1.63, 83.23) = 34.50, p < .001, \eta_p^2 = .40$]. The interaction effect between lag and valence did not reach statistical significance [$F(6, 305.91) = .32, p = .926, \eta_p^2 = .01$].

For the main effect of lag, pair-wise Bonferroni corrected comparisons revealed worse performance on trials at Lag 2 ($M = 48\%$) compared with Lag 7 ($M = 54\%$; $p = .011, d = .24$) [see Figure 4.2]. None of the other pairwise comparisons were significant.

For the main effect of valence, pair-wise Bonferroni corrected comparisons revealed worse performance on trials with positive ($M = 55\%$) and neutral ($M = 39\%$) faces compared with angry faces ($M = 60\%$; $p = .044, d = .21$ and $p < .001, d = .79$, respectively). Participants further performed worse on trials with neutral compared with positive faces ($p < .001, d = .62$) [see Figure 4.3].

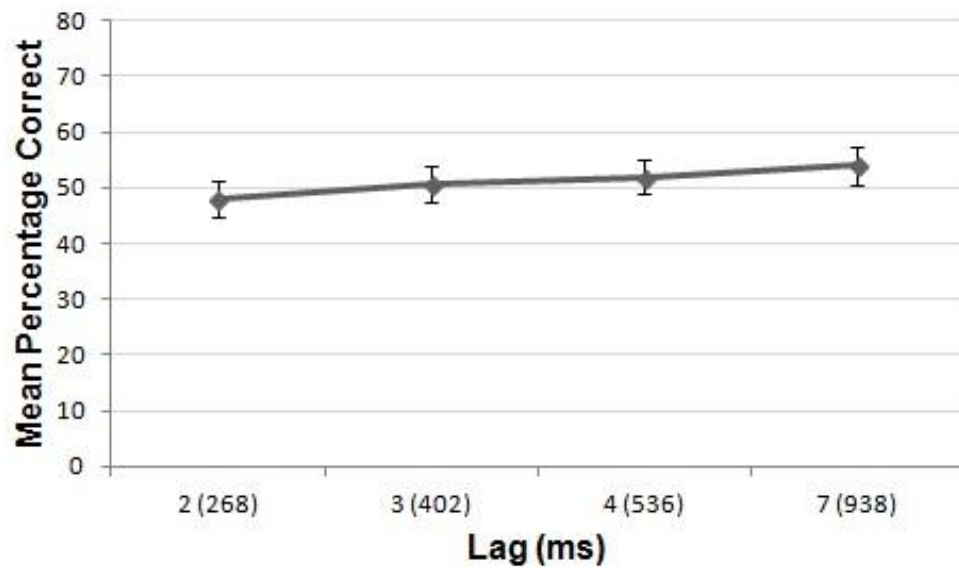


Figure 4.2 The mean percentage of correct responses for each lag. Error bars represent standard errors of the mean.

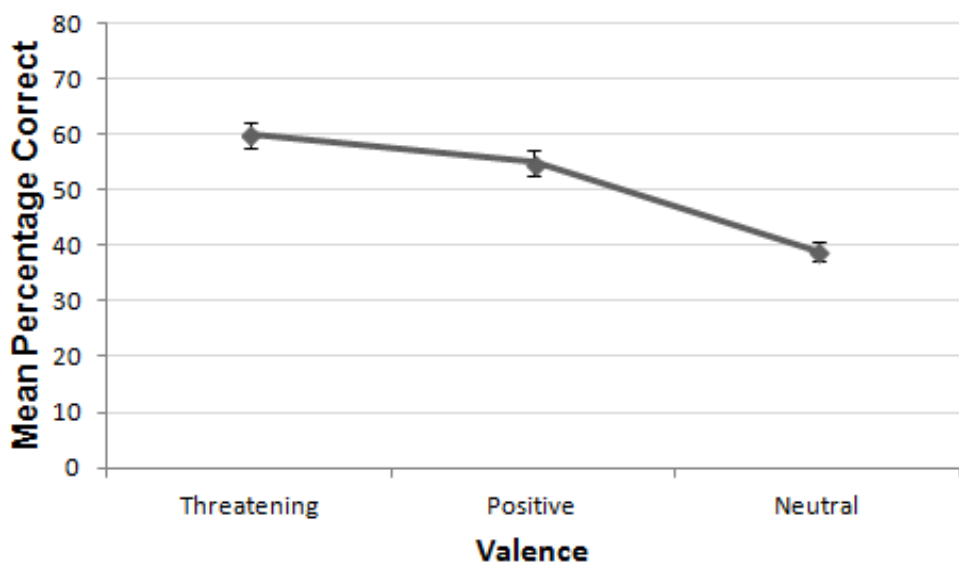


Figure 4.3 The mean percentage of correct responses for each valence. Error bars represent standard errors of the mean.

4.3.2 Trait Anxiety Analysis

Data were analysed from participants in high and low trait anxiety groups [see section 4.5.5 for descriptive statistics]. The mean overall percentage of correct responses was 55% ($SD = 25\%$) for HTA participants and 47% ($SD = 19\%$) for LTA. Table 4.2 shows the mean percentage of correct responses as a function of lag and valence for both HTA and LTA participants.

Table 4.2

Mean Percentage of Correct Responses as a Function of Lag and Valence (with Standard Deviations in Parentheses) for High and Low Trait Anxious Participants

Lag	High Trait Anxiety			Low Trait Anxiety			Total
	Threat'	Positive	Neutral	Threat'	Positive	Neutral	
2	60 (27)	55 (30)	42 (35)	55 (31)	48 (27)	28 (23)	48(25)
3	63 (25)	53 (28)	48 (35)	58 (26)	55 (24)	28 (27)	51(24)
4	63 (24)	55 (28)	48 (34)	57 (27)	59 (20)	29 (25)	52(23)
7	65 (28)	60 (27)	50 (32)	58 (27)	56 (25)	34 (26)	54(25)
Total	63 (24)	56 (26)	47 (32)	57 (24)	55 (21)	30 (23)	

To investigate the effects of trait anxiety on the AB, a mixed ANOVA was carried out with Trait Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. As Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 11.98, p = .002$], degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .86$). Results revealed that there were main effects for lag [$F(3, 150) = 4.31, p = .006, \eta_p^2 = .08$] and valence [$F(1.73, 82.30) = 37.20, p < .001, \eta_p^2 = .43$] but not trait anxiety [$F(1, 50) = 1.69, p = .200, \eta_p^2 = .03$]. Furthermore, there was a significant interaction between trait anxiety and valence [$F(1.73, 86.30) = 4.99, p = .012, \eta_p^2 = .09$] [see Figure 4.4]. However, the interaction effects between trait anxiety and lag [$F(3, 150) = .09, p = .968, \eta_p^2 = .01$], lag and valence [$F(6, 300) = .320, p = .926, \eta_p^2 = .04$], and trait anxiety, lag and valence [$F(6, 300) = 1.10, p = .363, \eta_p^2 = .14$] did not reach statistical significance.

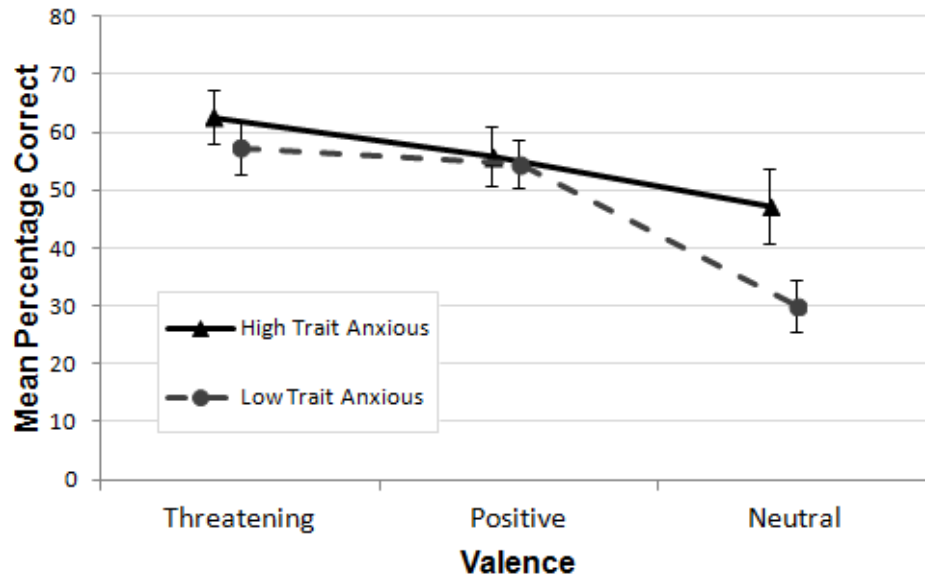


Figure 4.4 The effects of trait anxiety and valence on the percentage of correct responses. Error bars represent standard errors of the mean. Points are offset horizontally so that error bars are visible.

To clarify the trait X valence interaction, an independent t-test of the percentage of correct responses, with Trait Anxiety (high versus low) as the independent variable, was undertaken for each valence. Results showed that there was a significant difference in HTA and LTA participants' performance for neutral trials [$t(44.92) = -2.23, p = .031, d = .62$], such that HTA participants demonstrated higher performance on neutral trials ($M = 47$) compared with LTA participants ($M = 30$).

In addition, to further investigate group differences, a one-way Bonferroni corrected repeated measures ANOVA of the percentage of correct responses, with Valence (threatening, positive, and neutral) as the independent variable, was undertaken separately for each trait anxiety group (i.e., high versus low). As Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 11.98, p = .002$] in the low trait analysis, degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .84$). Results indicated that there were main effects of valence for both high [$F(2, 50) = 9.10, p < .001, \eta_p^2 = .27$] and low [$F(1.68, 41.97) = 31.33, p < .001, \eta_p^2 = .56$] trait anxious participants. Pair-wise Bonferroni corrected comparisons revealed that HTA participants performed better on threatening ($M = 63\%, SD = 24\%$) compared with neutral ($M = 47\%, SD = 32\%; p = .002, d = .57$) trials. There was also a trend towards significantly better

performance on threatening compared with positive trials ($M = 56\%$, $SD = 26\%$, $p = .069$, $d = .28$). However, there was no difference in performance between positive and neutral trials ($p = .121$, $d = .31$). LTA participants performed better on both threatening ($M = 57\%$, $SD = 24\%$; $p < .001$, $d = 1.15$) and positive ($M = 55\%$, $SD = 21\%$; $p < .001$, $d = 1.14$) trials compared with neutral ($M = 30\%$, $SD = 23\%$) trials. However, there was no difference in performance between threatening and positive trials ($p = .978$, $d = .09$).

4.3.3 State Anxiety Analysis

Data were analysed from participants in the high and low state anxiety groups [see section 4.2.5 for descriptive statistics]. The mean overall percentage of correct responses was 55% ($SD = 24\%$) for HSA participants and 48% ($SD = 21\%$) for LSA participants.

To investigate the effects of state anxiety on the AB, a mixed ANOVA was carried out with State Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. As Mauchly's test indicated that the assumption of sphericity had been violated for valence [$\chi^2(2) = 14.68$, $p = .001$], degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .83$). Results revealed that there were main effects for lag [$F(3, 150) = 4.37$, $p = .006$; $\eta_p^2 = .08$] and valence [$F(1.67, 83.26) = 33.71$, $p < .001$, $\eta_p^2 = .40$] but not for state anxiety [$F(1, 50) = 1.34$, $p = .249$, $\eta_p^2 = .03$]. The interaction effects between state anxiety and lag [$F(3, 150) = 1.33$, $p = .268$, $\eta_p^2 = .03$], state anxiety and valence [$F(1.67, 83.26) = .07$, $p = .899$, $\eta_p^2 = .00$], and state anxiety, lag and valence [$F(6, 300) = 1.61$, $p = .328$, $\eta_p^2 = .02$] did not reach statistical significance.

The main effects for lag and valence remained similar to those reported in section 4.3.1.

4.3.4 Effects of Age

It was not possible to investigate age effects since comparing Year 4 with Year 6 would have resulted in a participant sample of just 26, with only nine children in the Year 6 condition.

4.4 Discussion

The main purpose of the current investigation was to determine whether children display an attenuated AB for emotive, particularly threatening stimuli, and more importantly,

whether this effect is moderated by anxiety level when utilising a simplified version of the paradigm. Consistent with Investigation Two, it was observed that all children displayed an emotion-superiority effect, that is, performance was higher for both angry and positive face trials compared with neutral face trials throughout the AB task. However, of importance, it was further observed that performance was moderated by anxiety level. That is, HTA participants were: i) better at detecting both targets during threatening, relative to neutral, trials; and ii) marginally better at detecting both targets during threatening, relative to positive, trials. In contrast, LTA participants were better at detecting both targets during both threatening and positive trials compared with neutral trials. Finally, it was also found that HTA participants were better than LTA participants at detecting both targets during neutral trials. These findings will now be discussed in turn before a brief comparison of Investigation Two and Three are provided.

Both Investigation Two and the present investigation demonstrated that there was an emotion-superiority effect and that this did not depend on the lag between the T1 and T2. That is, children were more likely to detect both targets during threatening and positive trials compared with neutral trials, throughout the AB task. This finding supports hypothesis ii) [see section 4.1] and is in accordance with the research of de Jong and colleagues (de Jong et al., 2009; de Jong & Martens, 2007), who found that the AB effect was reduced when the T2 appeared as an emotive (i.e., angry or happy), relative to a neutral, face. This finding is consistent with the argument that the efficient processing of emotive facial expressions plays a critical role in interpersonal communication by providing non-verbal communication cues about behaviour (e.g., Goffman, 1967). Of importance, the current research extends this theory to child populations by demonstrating that eight to eleven year olds are also proficient at allocating attention towards non-verbal communication cues. Combined with Investigation Two, this appears to be the first research to demonstrate that differences in the preferential allocation of attention towards threatening (in this case, angry) and/or positive stimuli in relation to neutral stimuli (over time) is evident in children as well as adults.

Importantly, however, it was further observed that trait anxiety influenced the emotion-superiority effect. That is, HTA children were better at correctly identifying both targets when the T2 appeared as an *angry*, relative to a neutral, face and marginally better at correctly identifying both targets when the T2 appeared as an *angry*, relative to a positive, face. In contrast, LTA children performed better on both threatening *and* positive trials compared with neutral trials but there was no difference in performance for threatening,

relative to positive, trials. These findings support hypothesis iii) in section 4.1 and indicate that a child's tendency to preferentially allocate attentional resources to emotive stimuli is moderated by anxiety level. That is, highly anxious children appear to display a *threat* superiority effect, whereas those who are considered to be low anxious display a superiority effect of *emotion* per se. The finding that HTA children are more vigilant for threat is in accordance with previous adult AB studies investigating both clinical and non-clinical levels of anxiety (specific phobia - D'Alessandro et al., 2009; Reinecke et al., 2008; Trippe et al., 2007; state and/or trait anxiety - Barnard et al., 2005; Fox et al., 2005; Vaquero et al., 2006). For instance, Fox et al. (2005) found that the magnitude of the AB was significantly reduced for fearful, relative to happy, faces in high anxious, but not low anxious, adult participants. The current findings suggest that like adults, anxious children select and preferentially process threatening information.

This present result also accords well with a number of models of attentional bias and anxiety, namely Beck and Clark's (1997) 'information processing model', Mogg and Bradley's (1998) 'cognitive-motivational model' and Öhman's (1996, 2005) 'feature detection model'. These models theorise that facilitated engagement towards threat is an innate phenomenon that is present during early childhood and moderated by anxiety level. Beck and Clark (1997) further propose that facilitated engagement to threat is followed by more effortful and detailed elaboration of the threatening information, which results in a difficulty to disengage attention from the threatening stimulus. Thus, in extension of the present study, it is also necessary to examine the component of attentional disengagement in children. This will be accomplished in a subsequent investigation (i.e., Investigation Four, Chapter 5) by utilising an AB task that involves presenting a threatening stimulus as the T1. Manipulating the T1 enables researchers to investigate the speed and effectiveness with which attention is disengaged from emotive stimuli to allow for the processing of a subsequent (neutral) T2.

Results additionally revealed that HTA children's performance was higher than that of LTA children during neutral trials. This finding offers further support for Mogg and Bradley's (1998) 'cognitive-motivational model'. According to this theory, differences in attentional allocation to threat in HTA and LTA individuals can be expected for mild, but not severe, threat. This is apparently because high trait anxiety is linked to an oversensitive valence evaluation system (VES) [see Chapter 1, section 1.3.3.3], which results in the appraisal of ambiguous stimuli as threatening, and this information being attended to. In

contrast, this information will be appraised by LTA individuals as non-threatening, resulting in the information being unattended. This idea is in line with several cognitive models of information processing in anxious adults, which are associated with a different form of cognitive bias: interpretation bias (Beck, Emery, & Greenberg, 1985; Kendall, 1985; Muris & Field, 2008; Williams, Watts, MacLeod, & Mathews, 1997). For instance, Beck et al. (1985) postulated that maladaptive assumptions and beliefs play a role in the development and maintenance of anxiety disorders. More specifically, anxious individuals have a tendency to interpret numerous events, particularly those that they are uncertain about, as dangerous. In contrast, non-anxious individuals are more likely to interpret ambiguity as 'benign'. In support of this view, research in both adult (e.g., Amir, Foa, & Coles, 1998; Eysenck, Mogg, May, Richards, & Mathews, 1991; MacLeod & Cohen, 1993) and child (e.g., Barrett, Rapee, Dadds, & Ryan, 1996; Bell-Dolan, 1995; Bögels & Zigterman, 2000; Creswell, Schiering, & Rapee, 2005; Hadwin, Frost, French, & Richards, 1997; Waters, Craske, Bergman, & Treanor, 2008) samples has demonstrated that anxiety is associated with a propensity to interpret ambiguous information in a threatening manner. For example, Hadwin et al. (1997) utilised a homophone word task to examine anxiety-related interpretation bias in seven to nine year old children. This involved presenting an auditory set of words, which also included a series of ambiguous homophones (e.g., berry/bury; cross). Findings demonstrated that high, relative to low, anxious children were more likely to select pictures that reflected the threatening meaning of homophones (e.g., coffin versus fruit for 'berry/bury'; angry versus symbol for 'cross').

Although the interpretation bias is a well established phenomenon, it has not been implicated in previous studies investigating the AB in anxious individuals. Thus, the present investigation may be the first to demonstrate that HTA children display both an attentional bias *and* an interpretation bias for neutral faces in the AB paradigm. One reason this effect may not have arisen in the adult literature is that the majority of past studies have only compared negative with positive stimuli (e.g., Miyazawa & Iwasaki, 2010), hence preventing the emergence of any differences between emotive and neutral trials. Thus, it is important for future adult and child AB studies to attempt to replicate the present investigation findings. This will help to determine whether anxiety is indeed linked to an interpretation bias for neutral faces (which subsequently influences attentional bias) in adults as well as children. Future research should also examine whether this result is apparent for HTA children in the

spatial domain. This could, for example, be accomplished utilising a visual probe study and collecting valence and arousal ratings for the neutral stimuli.

The unexpected finding that attentional bias *and* interpretation bias may co-exist in children is important. At present, it is hypothesised that both biases are intricately linked, however, this relationship has yet to be established. It has been argued that one bias directly influences the other (Hirsch, Clark, & Mathews, 2006) and this has been supported by recent research (e.g., Amir, Bomyea, & Beard, 2010; White, Suway, Pine, Bar-Haim, & Fox, 2011). For instance, Amir et al. (2010) found that anxious individuals who were trained to interpret ambiguous stimuli as ‘benign’, relative to threatening, displayed an increased ability to rapidly disengage attention from such stimuli. However, to date, this research appears to have been conducted solely in adult populations. Thus, it may now be necessary to undertake such research in children. This could be accomplished utilising similar techniques to those of Amir et al. (2010).

One difference between the current findings and the majority of adult AB studies is the lack of any interaction effects. That is, in previous research, the *duration* of the AB has been found to be affected by the emotive content of the stimuli and/or the affective state of the individual. Specifically, Fox et al. (2005) found that for high anxious individuals, the AB effect was more short lived (i.e., up to 330 ms / Lag 3) for fearful faces compared with happy faces (i.e., up to 440 ms / Lag 4). Similarly, Maratos et al. (2008) found that the attenuated AB for threatening, relative to positive and neutral, faces was only present when the T2 appeared within 257 to 388 ms (i.e., Lags 2 to 3) of the T1. However, this was not the case in the present investigation, that is, both effects of valence and trait anxiety were independent of the time period between the T1 and T2. One possible explanation for this is that even though the AB task was simplified, results were still confounded by task difficulty. The average percentage of overall correct responses for the present investigation was 51% [see section 4.3.2.1], which is substantially higher than in Investigation Two (30%) [see Chapter 3, section 3.3.2.1]. Thus, it was concluded that simplifying the task by reducing the perceptual similarity between the distracters and targets resulted in the desired attenuation of the AB. This finding is in agreement with previous research that demonstrates a more severe AB effect with increased categorical or perceptual similarity between target and distracter items (Chun & Potter, 1995; Maki et al., 2003; Shapiro et al., 1994). However, the average percentage of overall correct responses in adult populations is approximately 70%. As such,

future research into anxiety and the AB in children could include a further simplified version of the task by ensuring that targets are even less similar to distracter items.

Finally, all children did display a typical blink effect. That is, children were poorer at detecting both targets in an RSVP stream when the T2 appeared at Lag 2 (or 268 ms after the T1). Additionally, performance did not significantly improve until the T2 appeared at Lag 7 (or 938 ms after the T1). This is in accordance with Investigations One and Two, and previous adult data (Broadbent & Broadbent, 1987; Raymond et al., 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987), and again demonstrates that children aged eight to eleven years are subject to the same processing limits as adults.

To summarise, findings from the present investigation suggest that eight to eleven year old children display an emotion-superiority effect for both angry and positive faces. However, findings further demonstrate that levels of trait anxiety moderate this emotion-superiority effect. Specifically, high trait anxiety was associated with an increased ability to correctly identify angry versus positive, and neutral, facial stimuli in children. The presence of this attentional bias offers support for cognitive theories of threat processing in anxiety, which posit that facilitated engagement for threat is an innate phenomenon that is present during early childhood and moderated by anxiety level. In addition, HTA individuals also performed better on neutral trials in comparison to LTA children. This offers support for cognitive models of information processing in anxiety, which postulate that maladaptive assumptions and beliefs, particularly about ambiguous situations, play a role in the development and maintenance of anxiety disorders. To the author's knowledge, this is the first study to demonstrate differences in processing facial stimuli in HTA compared with LTA children.

CHAPTER 5

Investigation Four: Disengagement from Emotive Stimuli during the Attentional Blink Task

5.1 Introduction

Findings from the previous investigation demonstrated that eight to eleven year old children were more likely to detect both targets in a rapid serial visual presentation (RSVP) paradigm when the second target (T2) appeared as either an angry or a positive, compared with a neutral, facial expression. This suggests that children display a superiority effect for emotive faces per se. Furthermore, it was observed that children with high levels of trait anxiety displayed increased performance for threatening, relative to neutral, trials and marginally increased performance for threatening, relative to positive, trials. It was also observed that these children performed better than those with low levels of anxiety on neutral trials. These findings indicate that highly anxious children display an attentional bias, in particular, *facilitated engagement*, towards both angry and neutral facial expressions. A further component of attentional bias, namely *disengagement*, can also be investigated utilising RSVP with the attentional blink (AB). This is achieved by presenting a salient stimulus as the first target (T1). Manipulating the T1 in this manner enables researchers to investigate the speed and effectiveness with which attention is disengaged from emotive stimuli to allow for processing of a subsequent (neutral) T2.

The majority of research investigating disengagement in the temporal domain has demonstrated that when the T1 is negatively valenced, the magnitude (Huang, Baddeley, & Young, 2008; Maratos, 2011; Most, Chun, Widders, & Zald, 2005; Srivastava & Srinivasan, 2010) and often the temporal duration (Ciesielski, Armstrong, Zald, & Olatunji, 2010; Mathewson, Arnell, & Mansfield, 2008; Smith, Most, Newsome, & Zald, 2006) of the AB is increased (*cf.* Steinmetz, Muscatell, & Kensinger, 2010). That is, individuals display a larger AB at shorter lags (i.e., Lags 2 to 3 / approximately 200 to 400 milliseconds [ms]) when the T1 is negative, and this effect is occasionally prolonged and evident at later lags (i.e., Lag 4 and over: approximately 600 ms and over). These findings suggest that individuals' attention is sustained by negative, relative to neutral and/or positive, stimuli, thus demonstrating

impaired disengagement from negative information (i.e., the T1). Consistent with this, research conducted by Ciesielski et al. (2010) has revealed that fearful and disgusting, relative to neutral, images presented as the T1 produced an AB of increased magnitude at Lag 2 (i.e., 200 ms). Furthermore, these images continued to induce greater deficits than did neutral images at the later lag times (i.e., 400 and 600 ms; Lags 4 and 6). These findings indicate that emotive stimuli capture and hold attention, thus interfering with the processing of succeeding information.

In contrast, Maratos (2011) has demonstrated that although a negative T1 is associated with an AB of greater magnitude, the effect is not necessarily of increased (i.e., prolonged) duration. Here, schematic faces varying in expression (angry, positive, or neutral) served as the T1 stimuli, neutral faces as the T2 stimuli, and scrambled faces as the distracter stimuli. Participants were required to indicate whether one or two faces had appeared in the RSVP stream and the valence of the face(s). Results demonstrated that although the AB was increased in magnitude for angry, compared with positive, T1 faces at Lag 2 (i.e., 257 ms), recovery from this effect was ‘faster’. That is, by Lag 3 (i.e., 388 ms), performance in reporting both targets during threatening, relative to positive, trials had significantly improved. An explanation for these findings is that threat is associated with initial *impaired* disengagement followed by *rapid* disengagement of attention and therefore, a *reduced*, rather than a *prolonged* AB. Indeed, as argued by Maratos (2011), a prolonged AB may not allow for rapid and effective behavioural responses, thus preventing efficient survival.

A reason for the discrepancy in findings discussed so far may be that there are methodological differences in relation to the stimulus type. More specifically, of the few studies that have incorporated facial stimuli, it appears that only that of Maratos (2011) has compared *threatening* (in this case, angry) versus positive/neutral faces. As highlighted in previous chapters [*see Chapter 2, section 2.6 and Chapter 3, section 3.1*], threatening facial expressions are thought to be biologically prepared because they are important from a survival/wellbeing perspective. Thus, it is argued that attentional prioritisation should be particularly apparent for these stimuli in order to allow for effective and rapid behavioural responses (LeDoux, 1996; Öhman, 1996). A plethora of brain-imaging, neurophysiological and neuropsychological studies have revealed that specialised neural networks involving regions of sub-cortical, visual, temporal and frontal brain regions are implicated in the rapid processing of threatening facial expressions (e.g., see Fossati, 2012; Iordan, Dolcos, & Dolcos, 2013; Pessoa & Adolphs, 2010 for reviews). For instance, Luo and colleagues (Luo,

Feng, He, Wang, & Luo, 2010) conducted an event-related potentials study in conjunction with RSVP and found that threatening facial stimuli were discriminated and processed more rapidly (i.e., within 300 ms of stimulus onset) than other, non-threatening stimuli. Therefore, it may be the case that threatening facial stimuli are attentionally prioritised in comparison to word, pictorial or non-threatening facial stimuli. Consequently, there is a need to further establish which components of attentional bias exist for threatening faces.

To date, few studies of *anxiety* have utilised RSVP with the AB to explore the effects of presenting an emotive stimulus as the T1 on the processing of a subsequently presented neutral stimulus. Of those studies that have, the research has focused solely on adult populations and findings are equivocal with regard to whether impaired disengagement is (Barnard, Ramponi, Battye, & Mackintosh, 2005; Most et al., 2005), or is not (Amir, Taylor, Bomyea, & Badour, 2009; Arend & Botella, 2002; Cisler, Ries, & Widner, 2007; Lystad, Rokke, & Stout, 2009), a component of attentional bias for threat associated with anxiety. For example, one study demonstrating impaired disengagement in adults is that of Barnard et al. (2005). This research involved utilising threatening words (e.g., ‘agony’, ‘fatal’, ‘molest’) as the T1 stimuli and neutral words describing specific professions (e.g., ‘baker’, ‘doctor’, ‘scientist’) as the T2 stimuli. The distracter stimuli consisted of words describing household objects (e.g., ‘blanket’, ‘doorway’, ‘stove’). Participants, divided according to state and trait anxiety, were required to identify the T2 in the RSVP stream. Findings revealed that participants who were high in both state and trait anxiety were less able to identify a T2 when it appeared four lags (i.e., 440 ms) after a threatening word - which is outside of the typical AB period (Broadbent & Broadbent, 1987; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986; Weichselgartner & Sperling, 1987). This finding offers support for Beck and Clark’s (1997) ‘information processing model’ of attentional bias for threat in anxiety. This postulates that facilitated engagement of threat is followed by more effortful and detailed elaboration of the threatening information, which is thought to result in a difficulty to withdraw attention from the threatening stimulus (Cisler & Koster, 2010) [*see Chapter 1, section 1.3.3.2 for further discussion*].

In contrast, further researchers investigating the relationship between anxiety level and the AB in adults have found a *reduction* in the AB effect (state anxiety - Lystad et al., 2009; trait anxiety - Arend & Botella, 2002). For instance, Arend and Botella (2002) utilised anxiety related and neutral words as the T1 and a neutral word (i.e., always ‘theatre’) as the T2. It was found that participants with high levels of trait anxiety displayed an attenuated AB

when the T1 stimulus appeared as an anxiety related word compared with a neutral word. Similar findings have also been evidenced in populations with anxiety related disorders (posttraumatic stress disorder - Amir et al., 2009; specific phobia - Cisler et al., 2007). It has been suggested that such findings may occur because anxious individuals require fewer attentional resources to process emotive stimuli, thus allowing for subsequent stimuli to be processed more rapidly (e.g., Amir et al., 2009). As stated earlier, a shorter AB may allow for efficient behavioural responses, which is advantageous in terms of survival/wellbeing (Maratos, 2011).

A limitation of the anxiety research discussed so far is that word stimuli were utilised. As previously argued, word stimuli are not biologically relevant and as such, do not encourage attentional prioritisation (LeDoux, 1996; Öhman, 1996). In more recent research, therefore, facial stimuli have been utilised. Here again, however, research is inconclusive. In brief, these studies investigating social anxiety (de Jong, Koster, van Wees, & Martens, 2009; de Jong & Martens, 2007) and non-clinical state anxiety (Peers & Lawrence, 2009) have revealed no differences in performance in anxious relative to non-anxious participants. For example, Peers and Lawrence (2009) included blue, colour-washed photos of neutral, disgusted, or fearful photographs of faces as the T1; pink, colour-washed photographs of neutral faces as the T2; and black and white neutral faces as the distracter stimuli. Findings did not reveal any differences related to target identification in low versus high state anxious participants. However, this study incorporated fearful faces, which are thought to be less directly threatening than angry faces (Bannerman, Milders, de Gelder, & Saharie, 2009; see Chapter 2, section 2.6 for further discussion). Hence it was again decided to utilise angry facial expressions in the current study, since these are argued to be more efficient at capturing visual attention.

Given the inconsistent findings and lack of research involving biologically prepared stimuli, there is a need to conduct further research utilising threatening, in particular, angry faces. Furthermore, there is a need to investigate processes of disengagement from threat in children as such research appears to have solely focused on adults. Accordingly, the main aim of the present investigation was to determine whether children with high levels of anxiety, like adults, display impaired and/or rapid disengagement of temporal attention from threatening, relative to positive and neutral, stimuli. This was achieved utilising an AB task in which the emotive content of the T1 was manipulated. Faces were included as the target stimuli because they: i) are biologically relevant (LeDoux, 1996; Öhman, 1996); ii) hold

increased ecological validity over other pictorial and word stimuli; and iii) help to prevent the potential confound of reading ability [*see Chapter 3, section 3.1, for further discussion*]. An angry face was chosen as the threatening stimulus given the argument that it is more efficient in capturing visual attention than a fearful face (Bannerman et al., 2009).

Based on the current research (i.e., Investigations One to Three), and findings from previous studies, it was hypothesised that all children would: i) display an AB effect of increased magnitude at earlier lag times (i.e., approximately 200-400 ms) compared with later lag times (i.e., over approximately 400 ms); and ii) display a different AB effect for emotive compared with neutral faces. It was further predicted that iii) high state and/or trait anxiety would affect the magnitude of the AB during threatening, relative to positive and neutral, trials. That is, high anxious children would display impaired and/or rapid disengagement from threat.

5.2 Methods

5.2.1 Pre-selection

A total of 123 children (58 male; 65 female) aged between eight and eleven years ($M = 9.20$, $SD = .88$) were recruited from a local primary school in Derbyshire, United Kingdom. This school received £50 worth of book vouchers for taking part. Participants undertook an initial pre-selection process, which involved completing the trait anxiety subscale of the State-Trait Anxiety Inventory for Children (STAIC-T; Spielberger, 1973) and the short version of the Children's Depression Inventory (CDI:S; Kovacs, 1992) [*see Chapter 3, section 3.2.1.3.2 for descriptions*]. Responses to the STAIC-T questionnaire were then utilised to assign participants to groups of high and low levels of trait anxiety utilising a tertile split. This resulted in approximately one third of the participants (i.e., those with medium levels of anxiety) being excluded. Mean ranking was utilised in the case of ties. In addition, participants who obtained a T-score of 65 or above on the CDI:S were deemed to be highly dysphoric and were subsequently excluded. Ethical approval was obtained from the University of Derby Psychology Research Ethics Committee.

5.2.2 Final Participants

Pre-selection resulted in a possible sample of 68 participants who were invited to take part in the experiment based on the following selection criteria: i) normal or corrected-to-

normal vision; ii) English as the first language; and iii) free from developmental disorders and learning disabilities, as reported by teachers. The final sample included 54 participants (24 male, 30 female) aged between eight and eleven years ($M = 9.19$, $SD = .89$).

5.2.3 Stimuli

Target stimuli consisted of four schematic faces varying in expression (angry, positive, and two neutral) and were identical to those utilised in the previous two investigations [see Chapter 3, section 3.3.1.2 and Figure 3.5]. Distracters consisted of two main features of each facial stimulus placed in random positions and orientations, and were identical to those utilised in the previous investigation [see Chapter 4, section 4.2.3 and Figure 4.1].

5.2.4 General Procedure

Participants were tested individually in a quiet area situated within the school grounds. School staff worked close by and the experimenter and child were always in view. First, the experimenter provided the participant with a brief explanation of the research (with the opportunity to withdraw) and presented the consent form. The experiment consisted of the administration of the state anxiety subscale of the STAIC (STAIC-S; Spielberger, 1973) [see Chapter 3, section 3.2.1.3.2 for a description] followed by the AB task. During the administration of the scale, the child was asked whether they: i) would like the experimenter to read each statement out loud to them and, in response, reply verbally and/or on paper; or ii) were comfortable with reading the statements and answering on their own. After the experiment, the child was thanked for taking part and debriefed as to the purpose of the experiment. It was ensured that all participants understood the project and they were then rewarded with a sticker for taking part. [See Appendix C for example covering letters, briefing/debriefing material and consent forms].

5.2.5 Attentional Blink Task Procedure

As in the previous attentional blink (AB) investigations [see Chapters 3 and 4], all trials contained a rapid serial visual presentation (RSVP) stream of 20 stimuli comprising one or two target stimuli and 18 or 19 distracter stimuli, respectively. The main RSVP task consisted of one block of 10 practice trials and two blocks of 60 test trials (i.e., 120 test trials in total, which were presented in a single session). Participants were allowed a short break

after having completed the first block of test trials. The practice block comprised two (20%) single target (i.e., one target stimulus) trials and eight (80%) double target (i.e., two target stimuli) trials. Test trials comprised double target trials only, since the aim of the study was to investigate the AB. Single target trials were included in the practice block to ensure that participants did not assume that the test trials included double target trials only.

At the beginning of each trial, a small circle was presented for approximately 134 ms at the central fixation point. After this, on double target trials, the stimulus presentation events were as follows: an initial random sequence of distracter stimuli (either five or eight consecutive stimuli), the first target (T1), a further random sequence of distracter stimuli (either one, two, three or six consecutive stimuli), the second target (T2), and then the remaining random distracter stimuli (ranging from four to twelve consecutive stimuli) [*see Figure 5.1*]. Thus, the trial events were as in the previous investigations reported in Chapter 3, sections 3.2.1.5 and 3.3.1.4, and Chapter 4, section 4.2.4. That is, the T2 was presented at Lag 2, Lag 3, Lag 4 and Lag 7 (268 ms, 402 ms, 536 ms and 938 ms, respectively).

After each RSVP stream, the participant was required to make two consecutive responses utilising a Cedrus RB-830 response pad. For the participant's first response, they were required to indicate the emotional expression of the *first* face viewed. This was done by pressing one of three buttons situated on the *left* of the response pad to indicate whether the first face seen was angry, positive or neutral. The participant was then required to indicate the emotional expression of the *last* face viewed by pressing one of three buttons situated on the *right* of the response pad. As with previous experiments in this thesis, in both cases the participant was required to indicate the face they had seen by simply matching it to an identical drawing on the response pad. To continue to the next trial, the participant then had to press a blue button situated at the bottom of the response pad. If only one face was viewed, they were required to select which one it was by utilising the left set of buttons and then pressing the blue button. They were also required to press the blue button if they had not seen any faces.

For each double target trial, the T1 was an angry, positive or neutral face and the T2 was always a neutral face (either N1 or N2). This resulted in three types of trial, which depended on the emotional expression displayed as the T1: i) Angry T1 – Neutral T2 (threatening trials); ii) Positive T1 – Neutral T2 (positive trials); and iii) Neutral T1 – Neutral T2 (neutral trials). During each trial, the T1 was always different to the T2; i.e., if the T1 was N1, the T2 was N2, or vice-versa. In an attempt to ensure that participants did not assume that

all the T2 stimuli were neutral in the test trials, two valences were included in the practice block: i) Neutral T1 – Angry T2 (two threatening trials) and ii) Neutral T1 – Positive T2 (two positive trials). There were 30 trials at each lag position (i.e., Lags 2, 3, 4 and 7) which comprised ten trials for every T1–T2 valence (i.e., threatening, positive and neutral trials).

The single target trials were the same as the double target trials, with the exception that only one target stimulus was presented (i.e., the T1 was replaced with a distracter stimulus). Only two single target trials were presented in the practice block: an angry face and a positive face, appearing in serial positions 8 and 16, respectively.

[Content removed for copyright reasons]

Figure 5.1 Example of a double target trial in which the T1 was an angry face and the T2 was a neutral face. Adapted from “Identification of Angry Faces in the Attentional Blink,” by F. A. Maratos, K. Mogg, and B. P. Bradley, 2008, *Cognition and Emotion*, 00, p. 5. Copyright 2008 by Psychology Press.

5.2.6 Data Analysis

Two participants' data were removed due to poor accuracy in identifying both targets (i.e., below two standard deviations of the sample mean). This resulted in a final participant sample of 52 children (24 male; 28 female) aged eight to eleven years ($M = 9.21$, $SD = .89$). These were 26 high trait anxious (HTA) (15 male, 11 female; age range = 8-11 years, M age = 9.15, $SD = .83$; M trait score = 44.35, $SD = 3.86$) and 26 low trait anxious (LTA) (9 male, 17 female; age range = 8-11, M age = 9.27, $SD = .96$; M trait score = 30.38, $SD = 2.95$) children. An independent measures t-test demonstrated that the HTA group had significantly higher scores than the LTA group [$t(50) = -14.65$, $p < .001$].

For the purpose of the state anxiety analysis, participants were assigned to groups of high and low levels of state anxiety based upon responses on the state anxiety subscale of the STAIC (STAIC-S; Spielberger, 1973). This resulted in 26 high state anxious (HSA) (14 male, 12 female; age range = 8-11 years, M age = 9.46, $SD = .81$; M state score = 30.62, $SD = 2.15$) and 26 low state anxious (LSA) (10 male, 16 female; age range = 8-11 years, M age = 8.96, $SD = .92$; M state score = 24.42, $SD = 2.35$) children. An independent measures t-test demonstrated that the HSA group had significantly higher scores than the LSA group [$t(50) = -9.90$, $p < .001$].

5.3 Results

5.3.1 Attentional Blink Analysis

Initially, data were analysed from the entire participant sample ($N = 52$). A correct response comprised of accurately identifying both the type (i.e., threatening, positive or neutral) and number of targets (i.e., two) in the RSVP stream. The mean overall percentage of correct responses was 53% ($SD = 19\%$). Table 5.1 shows the mean percentage of correct responses as a function of lag and valence.

To investigate the effects of emotive T1 stimuli on the AB, a repeated measures analysis of variance (ANOVA) of the percentage of correct responses was carried out with Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent variables. Mauchly's test indicated that the assumption of sphericity had been violated for both lag [$\chi^2(5) = 19.07$, $p = .002$] and valence [$\chi^2(2) = 16.41$, $p < .001$], therefore degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .83$, and $\epsilon = .80$, respectively).

Table 5.1

Mean Percentage of Correct Responses as a Function of Lag and Valence (with Standard Deviations in Parentheses)

	Lag 2	Lag 3	Lag 4	Lag 7	Total
Threatening	44 (27)	54 (28)	61 (23)	71 (19)	58 (20)
Positive	43 (23)	52 (24)	59 (22)	61 (25)	54 (19)
Neutral	38 (32)	42 (29)	49 (29)	53 (31)	46 (28)
Total	42 (23)	49 (22)	56 (19)	62 (20)	

Results showed that there were main effects for both lag [$F(2.49, 127.22) = 39.49, p < .001, \eta_p^2 = .44$] and valence [$F(1.60, 81.77) = 8.24, p = .001, \eta_p^2 = .14$]. Furthermore, results revealed that there was a significant interaction between lag and valence [$F(6, 306) = 2.19, p = .044, \eta_p^2 = .04$].

For the main effect of lag, pair-wise Bonferroni corrected comparisons revealed a typical blink effect. That is, participants performed worse on trials at Lag 2 ($M = 42\%$, $SD = 23\%$) compared with Lag 3 ($M = 49\%$, $SD = 22\%$; $p < .001, d = .37$), Lag 4 ($M = 56\%$, $SD = 19\%$; $p < .001, d = .74$), and Lag 7 ($M = 62\%$, $SD = 20\%$; $p < .001, d = 1.05$). Participants also performed worse on trials at Lag 3 compared with Lag 4 ($p = .003, d = .37$) and Lag 7 ($p < .001, d = .68$). Participants further performed worse on trials at Lag 4 compared with Lag 7 ($p = .018, d = .32$) [see Figure 5.2].

For the main effect of valence, pair-wise Bonferroni corrected comparisons revealed worse performance on trials with neutral faces ($M = 46\%$, $SD = 28\%$) compared with threat faces ($M = 58\%$, $SD = 20\%$; $p = .001, d = .63$) [see Figure 5.3]. No other pairwise comparisons were significant.

To clarify the lag X valence interaction, a one-way Bonferroni corrected ANOVA of percent correct responses, with Valence (threat, positive, neutral) as the independent variable was undertaken separately for each lag. Mauchly's test indicated that the assumption of sphericity had been violated for Lag 7 [$\chi^2(2) = 11.89, p < .05$], therefore degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .85$). Results showed that there were main effects for valence at Lag 3 [$F(2, 102) = 5.55, p = .005, \eta_p^2 = .10$], Lag 4 [$F(2, 102) = 5.81, p = .004, \eta_p^2 = .10$], and Lag 7 [$F(1.70, 86.64) = 9.87, p < .001, \eta_p^2 = .16$].

For the main effect of valence at Lags 3 and 4, pair-wise Bonferroni corrected comparisons revealed better performance on trials with angry faces compared with neutral faces (Lag 3: $p = .009$, $d = .63$; Lag 4: $p = .010$, $d = .63$). For the main effect of valence at Lag 7, pair-wise Bonferroni corrected comparisons revealed better performance on trials with angry faces compared with positive ($p = .012$, $d = .53$) and neutral ($p < .001$, $d = .95$) faces [see Figure 5.4].

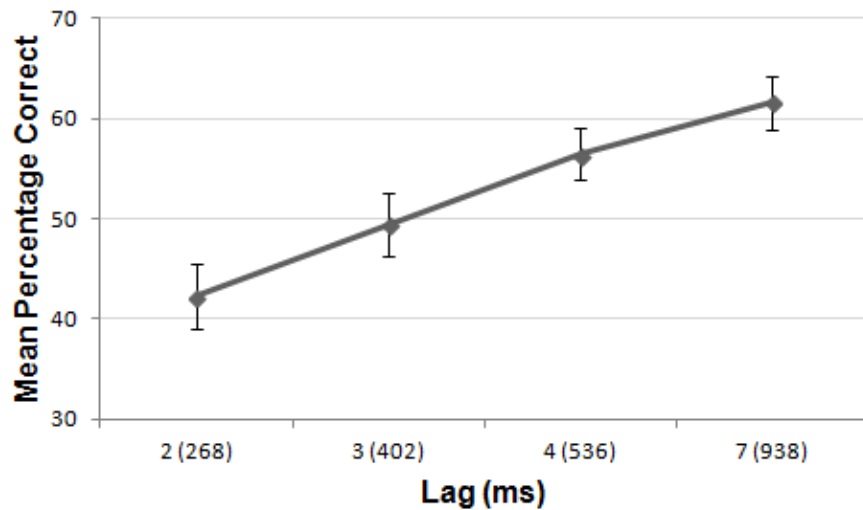


Figure 5.2 The mean percentage of correct responses for each lag. Error bars represent standard errors of the mean.

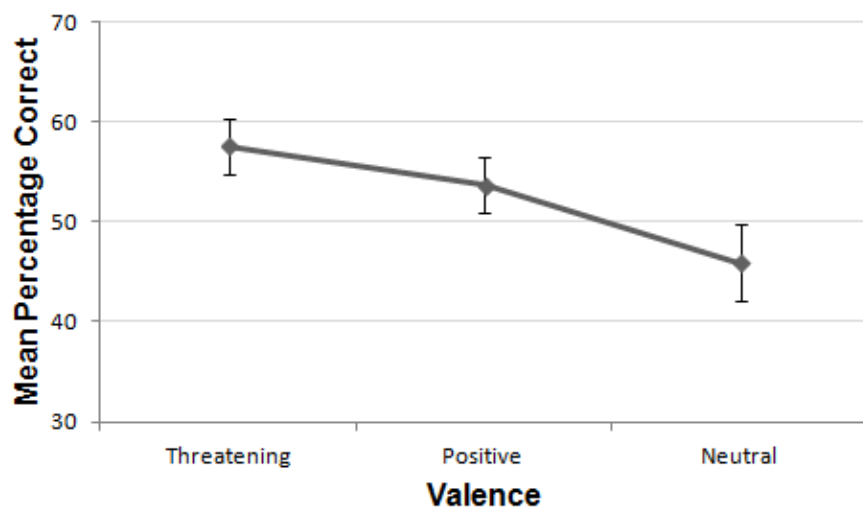


Figure 5.3 The mean percentage of correct responses for each valence. Error bars represent standard errors of the mean.

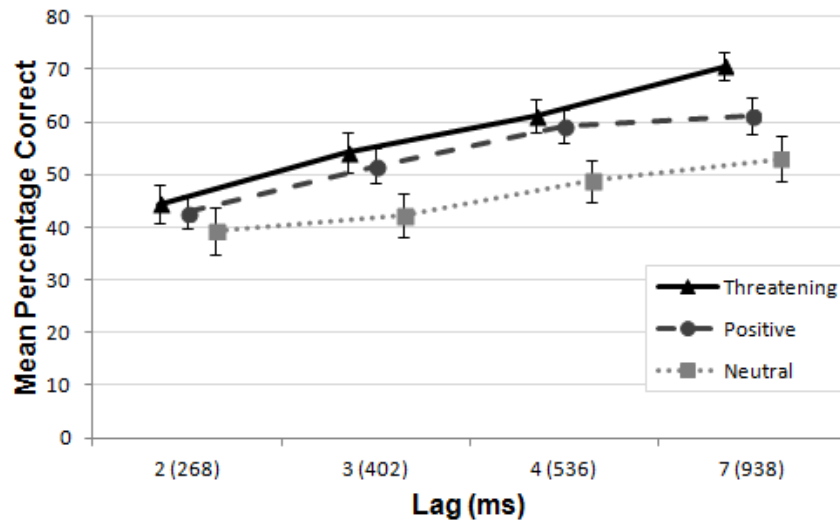


Figure 5.4 The effects of valence and lag on the percentage of correct responses. Error bars represent standard errors of the mean. Points are offset horizontally so that error bars are visible.

5.3.2 Trait Anxiety Analysis

Data were analysed from participants in the high and low trait anxiety groups [see section 5.2.6 for descriptive statistics]. The mean overall percentage of correct responses was 50% ($SD = 21\%$) for HTA participants and 55% ($SD = 18\%$) for LTA participants. Table 5.2 shows the mean percentage of correct responses as a function of lag and valence for both high and low trait anxious participants.

Table 5.2

Mean Percentage of Correct Responses as a Function of Lag and Valence (with Standard Deviations in Parentheses) for High and Low Trait Anxious Participants

Lag	High Trait Anxious			Low Trait Anxious			Total
	Threat'	Positive	Neutral	Threat'	Positive	Neutral	
2	42 (30)	42 (24)	34 (31)	47 (23)	44 (22)	45(32)	42 (27)
3	51 (31)	51 (27)	40 (31)	58 (26)	52 (22)	45 (27)	50 (27)
4	59 (22)	57 (19)	44 (30)	63 (24)	61 (24)	54 (28)	56 (25)
7	68 (22)	60 (26)	50 (32)	73 (17)	62 (25)	56 (30)	62 (25)
Total	55 (22)	53 (20)	42 (29)	60 (17)	55 (20)	50 (27)	

To investigate the effects of trait anxiety on the AB, a mixed ANOVA was carried out with Trait Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. Mauchly's test indicated that the assumption of sphericity had been violated for both lag [$\chi^2(5) = 18.87, p = .002$] and valence [$\chi^2(2) = 15.90, p < .001$], therefore degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .85$, and $\epsilon = .82$, respectively). There was a main effect for lag [$F(2.54, 127.06) = 38.83, p < .001, \eta_p^2 = .44$] and valence [$F(1.64, 82.00) = 8.14, p = .001, \eta_p^2 = .14$] but no main effect for trait anxiety [$F(1, 50) = .96, p = .332, \eta_p^2 = .02$]. As expected, results again showed that there was a significant interaction between lag and valence [$F(6, 300) = 2.16, p = .047, \eta_p^2 = .04$]. However, the interaction effects between trait anxiety and lag [$F(2.54, 127.06) = .14, p = .911, \eta_p^2 = .00$], trait anxiety and valence [$F(1.64, 82.01) = .43, p = .611, \eta_p^2 = .01$], and trait anxiety, lag and valence [$F(6, 300) = .29, p = .941, \eta_p^2 = .01$] did not reach statistical significance.

5.3.3 State Anxiety Analysis

Data were analysed from participants in the high and low state anxiety groups [*see section 5.2.6 for descriptive statistics*]. The mean overall percentage of correct responses was 51% ($SD = 20\%$) for HSA participants and 54% ($SD = 19\%$) for LSA participants.

To investigate the effects of state anxiety on the AB, a mixed ANOVA was carried out with State Anxiety (high versus low) as the independent between-groups variable, and Lag (2, 3, 4, and 7) and Valence (threatening, positive, and neutral) as the independent within-groups variables. Mauchly's test indicated that the assumption of sphericity had been violated for both lag [$\chi^2(5) = 17.84, p = .003$] and valence [$\chi^2(2) = 15.70, p < .001$], therefore degrees of freedom were corrected utilising Huynh-Feldt estimates of sphericity ($\epsilon = .86$, and $\epsilon = .82$, respectively). There was a main effect for lag [$F(2.58, 128.76) = 39.46, p < .001, \eta_p^2 = .44$] and valence [$F(1.64, 82.20) = 8.25, p = .001, \eta_p^2 = .14$] but no main effect for state anxiety [$F(1, 50) = .34, p = .565, \eta_p^2 = .01$]. Again, there was a significant interaction between lag and valence [$F(6, 300) = 2.19, p = .044, \eta_p^2 = .04$]. However, the interaction effects between state anxiety and lag [$F(2.58, 128.76) = .96, p = .404, \eta_p^2 = .02$], state anxiety and valence [$F(1.64, 82.20) = 1.12, p = .323, \eta_p^2 = .02$], and state anxiety, lag and valence [$F(6, 300) = 1.14, p = .337, \eta_p^2 = .02$] did not reach statistical significance.

5.4 Discussion

The main purpose of the current study was to determine whether children with high levels of anxiety demonstrate impaired and/or rapid disengagement from threatening, relative to positive and neutral, stimuli in the temporal domain. This was achieved utilising an RSVP paradigm in which the emotive content of the T1 was manipulated. Results demonstrated that although the AB was comparative across stimulus types at Lag 2 (i.e., 267 ms), an angry, relative to a neutral, T1 was associated with enhanced performance at Lags 3 and 4 (i.e., 400 ms and 534 ms). Furthermore, an angry, relative to a neutral and positive, T1 was associated with enhanced performance at Lag 7 (i.e., 935 ms). Thus, children displayed a more rapid recovery from the blink effect following an angry compared with a neutral (or positive) T1. These findings were, however, not affected by state or trait anxiety.

The finding that all children displayed rapid disengagement from an angry T1 stimulus supports hypothesis ii) [*see section 5.1*]. However, it is in contrast to the majority of adult studies, which have demonstrated impaired disengagement from negative/threatening stimuli (Huang et al., 2008; Mathewson et al., 2008; Most et al., 2005; Srivastava & Srinivasan, 2010). For example, Srivastava and Srinivasan (2010) found that a sad, relative to a happy, face was associated with an AB of increased magnitude for a subsequent neutral letter stimulus. This past research is limited though in that it incorporated stimuli with reduced ecological validity, such as letters/words or non-threatening (e.g., sad) faces. In contrast, the current investigation included angry (as well as positive and neutral) schematic faces, which are argued to be biologically prepared (e.g., Davis & Whalen, 2001; LeDoux, 1996; Mogg & Bradley, 1998; Öhman, 1996; Pessoa, 2005). Research by Maratos (2011) has also utilised schematic angry, positive and neutral T1 stimuli to demonstrate similar findings. That is, by Lag 3 (i.e., 388 ms), adults were better at reporting both targets when the T1 appeared as threatening, relative to positive. Thus, adults displayed a more rapid recovery from the blink effect following an angry compared with a neutral or positive T1. The present findings are consistent with this and extend findings to a child population.

Findings from the current investigation support cognitive models of threat processing, which postulate that attentional resources are preferentially assigned to threatening information. Indeed, these propose that the rapid identification of threat enables the early activation of defence mechanisms (LeDoux, 1996; Öhman, 1996). Thus, it may be the case that an ability to rapidly process threat and subsequently presented stimuli, as demonstrated

by the current study, allows for rapid and effective behavioural responses, which is advantageous in terms of survival/wellbeing (Maratos, 2011). Since the present study involved children, it may be the case that humans have an innate bias to rapidly process threat. The observation that children are able to rapidly attend to, process and shift attention from angry, relative to positive and neutral, faces provides support for the existence of an evolved attentional bias for threat. As argued by evolutionary theorists, humans who effectively learned to fear threatening faces (and other threat relevant stimuli, e.g., snakes, spiders), would have been more likely to thrive and successfully produce and nurture offspring. Thus, humans developed an innate ability to rapidly distinguish threats that were present and recurrent throughout evolutionary history (Öhman, 1993; Öhman & Mineka, 2001, 2003; Seligman, 1971). One question for future research might be whether *infants*, like adults (Maratos, 2011) and children (as shown in the present study), demonstrate rapid disengagement from angry faces in an AB task. This would provide stronger evidence for whether an innate bias to rapidly process angry faces exists in humans. According to Rakison and Derringer (2008) infants may have an innate mechanism, namely the ‘perceptual template’, for detecting threat-relevant stimuli. As a result, humans may have a predisposed preference for representations that have the basic composition of an angry face (such as schematic facial stimuli).

Like Maratos (2011), a reduced blink effect was not observed at Lag 2 in the present study. Instead, no differences were found between the stimulus types. A possible reason for this is that all targets presented at this lag were subject to the blink effect, which typically occurs within 200-400 ms; especially as the T2 was neutral, and thus, non-salient, in content. That is, participants may have focused attentional resources completely on the emotive T1 stimuli, thus rendering these resources unavailable for processing the neutral T2 within this short duration (see Dux & Marois, 2009; Shapiro, Arnell, & Raymond, 1997 for reviews).

In relation to anxiety, the present study offers no support for hypothesis iii) [*see section 5.1*] since it did not demonstrate any differences in temporal attention for emotive stimuli. This finding is in contrast to the study of Barnard et al. (2005), in which threatening words held the attention of highly anxious adults, thus impeding on the processing of subsequently presented stimuli. It is also in opposition with research that has revealed more rapid processing of subsequently presented stimuli in those with higher levels of anxiety (Amir et al., 2009; Arend & Botella, 2002; Cisler et al., 2007; Lystad et al., 2009). However, the current finding *is* in accordance with previous AB studies that have utilised *facial*

expressions (de Jong et al., 2009; de Jong & Martens, 2007; Peers & Lawrence, 2009). For example, Peers and Lawrence (2009) found that low versus high state anxious adults did not differ in their ability to identify disgusted, fearful, or neutral faces. Thus, current findings regarding the relationship between processes of disengagement and anxiety are equivocal suggesting that further research is required.

Taken together, findings from both the previous investigation [*Investigation Three, Chapter 4*] and the present study suggest that anxiety is associated with facilitated engagement of threatening stimuli but not impaired or rapid disengagement of temporal attention for biologically prepared, threatening stimuli. This accords with Mogg and Bradley's (1998) 'cognitive-motivational model' and Öhman's (1996, 2005) 'feature detection model' of attentional bias and anxiety. Both postulate that facilitated engagement for threat is an innate phenomenon that is present during early childhood and moderated by anxiety level. In contrast, the present results do not offer support for Beck and Clark's (1997) 'information processing model' of attentional bias and anxiety. In this model, facilitated engagement of threat is followed by more effortful and detailed elaboration of the threatening information, which is thought to result in a difficulty to disengage attention from the threatening stimulus.

This discussion highlights the need to employ a range of different experimental paradigms to investigate anxiety and the specific processes of attentional disengagement. For instance, paradigms such as visual search, spatial cueing and visual probe could be utilised to investigate attention within the spatial domain [*see Chapter 2, section 2.3 for further discussion*]. Koster, Crombez, Verschuere, and De Houwer (2006) conducted a visual probe task that included highly threatening, mildly threatening, and neutral pictures. It was found that during incongruent highly threatening trials, HTA adults were slower than LTA participants to respond to probes that followed neutral pictures. This suggests that participants had difficulty in withdrawing attention from the angry face. Thus, the theory that anxiety influences processes of disengagement cannot yet be disregarded. As such, it is necessary to provide a more comprehensive investigation of the effects of anxiety on attentional bias in children. This can be achieved by conducting further investigation into the spatial components of attentional bias.

To sum, findings from the present investigation suggest that eight to eleven year old children disengage attention more rapidly from angry faces compared with neutral (or positive) faces. The presence of this attentional bias in children offers support for theories

postulating the existence of an innate mechanism for the detection of biologically prepared threat stimuli in humans. Findings further suggest that levels of anxiety do not affect eight to eleven year old children's temporal attention for emotive stimuli. Taken with findings from the previous investigation [*Investigation Three, Chapter 4*], this suggests that anxiety in children is associated with facilitated engagement to but not impaired or rapid disengagement from angry faces in the temporal domain. This supports theories of attentional bias for threat in anxiety, which posit that facilitated engagement to threat is an innate phenomenon that is present during early childhood and moderated by anxiety level.

CHAPTER 6

Investigation Five: Covert Attentional Bias for Emotive Stimuli during the Visual Probe Task

6.1 Introduction

Findings from the previous attentional blink (AB) investigation suggest that eight to eleven year old children rapidly disengage temporal attention from angry, compared with positive and neutral, facial expressions [*see Chapter 5*]. In relation to anxiety, findings from Investigations Three and Four imply that high trait anxiety is associated with facilitated engagement towards angry, relative to neutral and positive, faces; but not impaired/rapid disengagement from angry, relative to neutral and positive, faces [*see Chapters 4 and 5*]. In addition, findings from Investigation Three suggest that high trait anxious children interpret neutral faces as more ambiguous and hence, more threatening [*see Chapter 4*]. However, for a more comprehensive understanding of the components of attentional bias in relation to the development of anxiety, it is also necessary to examine spatial attention. Consequently, the current investigation will utilise visual probe (VP) methodology to examine all components of attentional bias, that is, facilitated engagement, impaired disengagement, *and* avoidance, in the spatial domain.

The VP paradigm is the most frequently applied methodology in the exploration of the effects of anxiety on spatial biases of attention (Staugaard, 2010). An advantage of the VP paradigm is that it promotes competition among stimuli, which is thought to be a prerequisite for attentional bias to emerge (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). This is because multiple stimuli often compete for attention in the natural environment. As discussed in Chapter 2 [*see section 2.3.3*], the VP task typically involves presenting a pair of stimuli (e.g., facial expressions) side by side on a visual display (e.g., computer monitor). One of the stimuli is emotive (e.g., angry or happy facial expression) and the other is neutral. The pair is presented briefly (typically for 500 milliseconds [ms]; see Mogg & Bradley, 1998 for a review) before being extinguished (i.e., vanishing) and replaced immediately by a probe (e.g., an asterisk or a dot). The probe appears in one of the locations previously occupied by a stimulus; that is, it can appear in either the place of the emotive or the neutral stimulus. Trials in which the probe appears in place of the emotive stimulus are

referred to as ‘congruent’, whereas trials in which the probe appears in place of the neutral stimulus are referred to as ‘incongruent’. Following these trial events, participants are required to respond to the probe as quickly and as accurately as possible by: i) indicating when the probe appears; ii) classifying its location (e.g., left vs. right); or iii) classifying the type of probe displayed (e.g., : vs. ..), depending on the task version.

It is reasoned that individuals respond more rapidly to a probe when it appears in an attended, as opposed to an unattended, spatial location. Conversely, individuals respond more slowly to a probe when it appears in an unattended, rather than an attended region (Posner, Snyder, & Davidson, 1980). In studies of anxiety, the VP task has provided consistent evidence that anxious, relative to non-anxious, adults are faster to respond to probes that replace threatening rather than neutral stimuli. This evidence of an attentional bias towards threat has been demonstrated for both typographical and pictorial stimuli and in a variety of anxious adult populations (for reviews, see Bar-Haim, et al., 2007; Frewen, Dozois, Joanisse, & Neufeld, 2008), including generalised anxiety disorder (e.g., Bradley, Mogg, White, Groom, & de Bono, 1999), social anxiety disorder (e.g., Mogg, Phillipott, & Bradley, 2004) and non-clinical anxiety (e.g., Bradley, Mogg, Falla, & Hamilton, 1998; Ioannou, Mogg, & Bradley, 2004; Mogg & Bradley, 1999).

Findings from child VP studies employing word stimuli are consistent with the adult literature. That is, anxious, relative to non-anxious, children typically display an attentional bias towards threatening words (e.g., Hunt, Keogh, & French, 2007; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999; Vasey, Daleiden, Williams, & Brown, 1995). More recently, child VP studies have investigated attentional bias for pictorial stimuli, including standardised affective pictures (e.g., International Affective Picture Set [IAPS], Lang, Bradley, & Cuthbert, 1999) and emotive facial expressions (e.g., NimStim, Tottenham et al., 2009). Research incorporating the former is currently mixed, with findings demonstrating both an attentional bias towards (Waters, Lipp, & Spence, 2004; Waters, Wharton, Zimmer-Gembeck, & Craske, 2008) *and* an attentional bias away from (Legerstee et al., 2009) threatening images in clinically anxious children. In studies that have incorporated emotive facial expressions, the majority have revealed an attentional bias towards angry faces. This has been observed in children with generalised anxiety disorder (Monk et al., 2006; Roy et al., 2008; Waters, Kokkoris, Mogg, Bradley, & Pine, 2010), children with both current bipolar disorder and a history of anxiety (Brotman et al., 2007), and those with high levels of trait anxiety (Heim-Dreger, Kohlmann,

Eschenbeck, & Burkhardt, 2006; Telzer et al., 2008). However, some research has also provided evidence of an attentional bias away from angry faces in both clinically (Monk et al., 2008; Pine et al., 2005) and non-clinically anxious children (Stirling, Eley, & Clark, 2006).

One reason that the child literature concerning pictorial stimuli is currently mixed may be the stimulus exposure duration utilised; that is, typically 500 ms. According to Cooper and Langton (2006), initial VP studies assumed that a presentation time of 500 ms allowed for the measurement of initial attentional allocation. However, eye movement research has revealed that more than one shift in observable eye-gaze / fixations is likely to occur within this time period (Kowler, Anderson, Doshier, & Blaser, 1995). Thus, a stimulus duration of 500 ms may not catch initial attentional allocation but rather voluntary (and *overt*) attention. Accordingly, it may be more beneficial to include shorter stimulus presentations that allow for the measurement of *covert* attention, which is a shift in the focus of attention *not* accompanied by eye or head movements (Posner, 1980). It has been found that it takes at least 200 ms after stimulus onset to initiate a saccadic eye movement, making it unlikely that overt eye movements will occur before this time period (Stevens, Rist, & Gerlach, 2011). This implies that a stimulus exposure duration of 200 ms or less is required to measure covert attention.

To date, few studies appear to have investigated covert biases of spatial attention. Of those that have, findings typically demonstrate an attentional bias towards threat in anxious individuals (Carlson & Reinke, 2008; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, de Bono, & Painter, 1998; Stevens, Rist, & Gerlach, 2009). For example, Mogg et al. (1997) found that with an exposure duration of 100 ms, high state anxious participants responded more rapidly to probes that replaced threatening words rather than probes that replaced neutral words. However, this previous research focused on adults and, to date, it appears that no child VP studies have investigated covert attentional bias for threat in anxiety. This may further be due to a limited understanding of when covert attention begins to develop. As highlighted by Bornstein and Lamb (2011), studies relating to the neural basis of covert attention in children have only recently begun to emerge. This said, an event-related potentials (ERP) study by Richards (2003) has revealed that although there was little evidence for covert attention in three month old infants, the pattern of ERP data resembled that of adults by the time infants reached five months. This indicates that even very young

infants (i.e., those from the age of five months) are able to covertly shift attention to cued locations.

Additionally, a major limitation of much of the past VP research investigating anxiety and attentional bias is that it has failed to determine the specific components of attentional bias. To expand, it has been highlighted that an attentional bias towards emotive stimuli may reflect either facilitated engagement towards, *or* impaired disengagement from, such stimuli (Koster, Crombez, Verschuere, & De Houwer, 2004; Posner & Peterson, 1990; Salemink, van den Hout, & Kindt, 2007). Thus, Koster et al. (2004) have proposed a method to disentangle the two components, which requires that trials in which both stimuli are neutral are included in the paradigm. It is then necessary to compare reaction times (RTs) during these neutral trials with RTs during congruent and incongruent trials.

According to Koster et al. (2004), faster RTs during congruent trials compared with neutral trials indicates facilitated engagement towards emotive stimuli, whereas slower RTs on incongruent trials compared with neutral trials indicates impaired disengagement from emotive stimuli. Recently, Legerstee et al. (2009) have further argued that an attentional bias away from emotive stimuli may indicate either avoidance of, *or* a tendency not to engage with, these stimuli. They suggest that faster RTs during incongruent trials compared with neutral trials indicates avoidance of emotive stimuli, whereas slower RTs during congruent trials compared with neutral trials indicates a tendency not to engage or shift attention towards emotive stimuli. The different components of attentional bias and how it is possible to distinguish between them is summarised in Table 6.1.

Table 6.1

Disentangling the Specific Components of Attentional Bias

[Content removed for copyright reasons]

Adapted from “Threat-related selective attention predicts treatment success in childhood anxiety disorders,” by J. S. Legerstee et al., 2009, *Journal of the American Academy of Child and Adolescent Psychiatry*, 48, pp. 196-205. Copyright 2009 by the American Academy of Child and Adolescent Psychiatry.

Of the few studies that have attempted to disentangle the components of attentional bias, findings have demonstrated facilitated engagement to threat when stimuli are presented for short time periods (100 ms - Carlson & Reinke, 2008; Koster, Verschuere, Crombez, & Van Damme, 2005), but impaired disengagement when stimuli are presented for longer durations (e.g., 500 ms; Koster, Crombez, Verschuere, & De Houwer, 2006; Koster, Crombez, Verschuere, & De Houwer, 2004; Salemink et al., 2007). It appears that only one child VP study has attempted to disentangle the components of attentional bias for emotive stimuli (Legerstee et al., 2009). However, this study focused on the success of cognitive behavioural therapy, did not utilise facial expressions and only included a stimulus presentation time of 500 ms. As such, it is necessary to ensure that this methodology is included in future research, particularly with children.

Considering the above, the main aim of the present investigation was to utilise the VP paradigm to determine whether children with high levels of anxiety, like adults, demonstrate a covert attentional bias for angry, relative to happy and neutral faces. A further aim was to determine the specific component(s) of attentional bias. Based on findings from previous VP studies of covert attention in adults, it was hypothesised that i) high state and/or trait anxious children would display facilitated engagement towards angry, relative to happy and neutral faces.

Note also, since findings from Investigation Three [*see Chapter 4*] demonstrated that children with high, relative to low, levels of trait anxiety were more accurate in identifying neutral faces, the current study also tested each child's subjective appraisal of each face type. It was hypothesised that ii) there would be a difference in the valence and arousal ratings of neutral faces for high trait versus low trait anxious children.

Furthermore, the present investigation included the additional measure of attentional control (AC) since it has been posited that levels of anxiety interfere with an individual's ability to regulate attentional allocation (Eysenck, Derakshan, Santos, & Calvo, 2007; see section 6.2.4.1 for further information). It was predicted that iii) any finding related to impaired disengagement from threat in high anxious children would be associated with low levels of AC.

6.2 Methods

6.2.1 Pre-selection

A total of 124 children (65 male; 59 female) aged eight to eleven years ($M = 9.17$; $SD = 0.88$) were recruited from a local primary school in Derbyshire, United Kingdom. This school received £50 worth of book vouchers for taking part. Participants undertook an initial pre-selection process, which involved completing the trait subscale of the State-Trait Anxiety Inventory for Children (STAIC-T; Spielberger, 1973) and the short version of the Children's Depression Inventory (CDI:S; Kovacs, 1992) [see Chapter 3, section 3.2.1.3.2 for descriptions]. Participants were then assigned to groups of high and low levels of trait anxiety utilising a tertile split, which resulted in approximately one third of the participants (i.e., those with medium levels of anxiety) being excluded. Mean ranking was utilised in the case of ties. In addition, participants who obtained a T-score of 65 or above on the CDI:S were deemed to be highly dysphoric and were subsequently excluded. Ethical approval was obtained from the University of Derby Psychology Research Ethics Committee.

6.2.2 Final Participants

Pre-selection resulted in a possible sample of 75 participants who were invited to take part in the experiment based on the following selection criteria: i) normal or corrected-to-normal vision; ii) English as the first language; and iii) free from developmental disorders and learning disabilities as reported by teachers. This resulted in a final sample of 54 children (28 male; 26 female) aged between eight and eleven years ($M = 9.15$; $SD = .92$), all of whom took part in the main experiment.

6.2.3 Stimuli

The facial stimuli were 24 pictures of facial expressions taken from the NimStim face set (Tottenham et al., 2009). These included angry, happy and neutral facial expressions [see Figure 6.1 for an example] from eight actors (four male; four female) of varying race (i.e., African-American, Asian-American, European-American and Latino-American). The ability to use equal numbers of male and female actors across a range of ethnicities is one of the advantages of utilising the NimStim face set. That said, it does not include Asian-American males and as such, two males of a different ethnicity were incorporated instead. A further benefit of utilising the NimStim face set is that it provides both closed- and open-mouthed

versions of the angry, happy, and neutral faces. The open-mouthed versions were included in the present investigation because it has been found that: i) attentional bias increases as the intensity of the angry expression increases (Wilson & MacLeod, 2003); and ii) open-mouthed angry faces have higher validity ratings than closed-mouthed angry faces on average (Tottenham et al., 2009). Validity and reliability ratings for each of the faces featured in the present research are provided in Table 6.2. These ratings are based on 81 untrained research participants who took part in Tottenham et al.'s (2009) psychometric evaluations of the stimuli.

Table 6.2

Gender, Ethnicity, Reliability and Validity Scores for all Actors and Facial Expressions Utilised in the Current Research.

[Content removed for copyright reasons]

Adapted from “The NimStim set of facial expressions: Judgements from untrained research participants,” by N. Tottenham et al., 2009, *Psychiatry Research*, 168. Copyright 2008 by Elsevier Ireland Ltd.

It was necessary to modify faces in an attempt to control for a number of potential confounds. This process was initially undertaken utilising Adobe Photoshop CS3 software. Firstly, faces were converted from RGB colour to monochrome in order to prevent differences in attentional allocation due to colour variations. Secondly, extraneous features

(i.e., ears and hair) were removed with the aid of an elliptical mask template in order to prevent participants from allocating attention to irrelevant features. Furthermore, the masked area was set to black. Lastly, luminance levels were normalised utilising MATLAB 7.12.0 software in order to prevent differences in attentional allocation being due to variations in luminance levels. This was undertaken by calculating the overall mean intensity of all three faces (ignoring the black background) and then applying the mean difference to each face individually [see Figure 6.2 for examples; see Appendix D for all modified faces].

[Content removed for copyright reasons]

Figure 6.1 Example of an angry, happy and neutral facial expression from the NimStim face stimulus set (actor 3; Adapted from “The NimStim set of facial expressions: Judgements from untrained research participants,” by N. Tottenham et al., 2009, *Psychiatry Research*, 168. Copyright 2008 by Elsevier Ireland Ltd.).

[Content removed for copyright reasons]

Figure 6.2 Example of a modified angry, happy and neutral facial expression from the NimStim face stimulus set (actor 3; Adapted from “The NimStim set of facial expressions: Judgements from untrained research participants,” by N. Tottenham et al., 2009, *Psychiatry Research*, 168. Copyright 2008 by Elsevier Ireland Ltd.).

Each face measured ~7.5 X 10 cm and subtended visual angles of ~7.13 X 9.46 degrees when presented on the screen. The distance between the centres of the faces (i.e., the nose tips) was ~13 cm or rather ~12.23 visual degrees. This is similar to previous VP studies in anxious children (e.g., Elam, 2010; Waters et al., 2008; Waters et al., 2010).

6.2.4 Self-Report Measures

In addition to the self-report measures utilised in the pre-selection process, the present investigation also included the state subscale of the STAIC (STAIC-S; Spielberger, 1973) [see Chapter 3, section 3.2.1.3.2 for a description] to measure for levels of state anxiety and the child version of the Attentional Control Scale (ACS-C; Muris, de Jong, & Engelen, 2004) to measure for levels of attentional control (AC) [see Appendix E for a copy of the ACS-C].

6.2.4.1 Attentional Control

The ACS-C scale was included as a control measure in the present investigation since it has been posited that levels of anxiety interfere with an individual's ability to regulate attentional allocation (Eysenck et al., 2007). More specifically, this theory argues that high levels of anxiety: i) reduce the degree to which inhibitory mechanisms are able to regulate automatic responses; and ii) increase the degree to which attention is shifted from one task to another. It has been suggested that these effects may manifest by: i) difficulty in disengaging attention from threat; and ii) facilitated engagement towards threat, respectively (Cisler & Koster, 2010).

The ACS-C is a simplified version of the Attentional Control Scale (ACS; see Derryberry & Reed, 2002). It is a 20-item self-report questionnaire with a four-point rating scale (one = *almost never*, two = *sometimes*, three = *often*, four = *always*) measuring two types of AC: attentional inhibition / focusing (nine items; e.g., 'My concentration is good, even when somebody turns the music on') and attentional shifting (eleven items; e.g., 'It is easy for me to switch back and forth between two different tasks'). The construct of attentional focusing has been defined as "*the capacity to intentionally hold the attentional focus on desired channels and thereby resist unintentional shifting to irrelevant or distracting channels*" and attentional shifting as "*the capacity to intentionally shift the attentional focus to desired channels, thereby avoiding unintentional focusing on particular channels*" (Derryberry & Rothbart, 1988, p. 966). Higher scores reflect lower levels of AC and lower scores reflect higher levels of AC.

Muris et al. (2004) conducted a pilot study of 167 children aged between eight and thirteen years and found that the scale is internally consistent ($\alpha = 0.72$), correlated positively with perceived control ($r = 0.22$), and negatively with trait anxiety ($r = -0.38$). However, on the basis of feedback from initial participants in the current investigation, it was necessary to

alter the wording of five items in order to ensure that children were able to understand and/or relate to them more easily [see Table 6.3].

Table 6.3

Original and Revised Items from the Attentional Control Scale for Children (ACS-C; Muris et al., 2004)

[Content removed for copyright reasons]

Adapted from “Relationships between neuroticism, attentional control, and anxiety disorder symptoms in non-clinical children,” by P. Muris, P. J. de Jong, and S. Engelen, 2004, *Personality and Individual Differences*, 37. Copyright 2003 by Elsevier Ltd.

6.2.5 General Procedure

Based on the pre-selection process, participants with high or low levels of trait anxiety (and low levels of dysphoria) were invited to participate in the main experiment. Parents/guardians were required to provide informed, written consent for this phase of the research. Participants were tested individually in a quiet area situated within the school grounds. School staff worked close by and the experimenter and child were always in view. Prior to data collection, the experimenter always provided the participant with a brief explanation of the research (with the opportunity to withdraw) and presented the consent form. The experiment consisted of the administration of both the STAIC-S (Spielberger, 1973) and the ACS-C (Muris et al., 2004), the visual probe (VP) task, and the subjective appraisal task. After the experiment, the child was thanked for taking part and debriefed as to

the purpose of the experiment. It was ensured that all participants understood the project and following participation they were each rewarded with a sticker for taking part. [See Appendix C for example covering letters, briefing/debriefing material and consent forms].

6.2.6 Administration of Self-Report Measures

During the experiment, participants were initially asked to complete the STAIC-S (Spielberger, 1973). The researcher asked each participant whether: i) they would like the experimenter to read each statement out loud to them and, in response, reply verbally and/or on paper; or ii) they were comfortable with reading the statements and answering on their own. Responses to the STAI-C were utilised to assign participants to groups of high and low levels of state anxiety after the experiment had taken place.

The ACS-C (Muris et al., 2004) was then administered. This was read out loud and participants were required to reply by marking their answers on the questionnaire. This questionnaire phase of the research took approximately 15 minutes.

6.2.7 Visual Probe Task

The VP task was programmed utilising Inquisit (www.millisecond.com) experimental software and was presented on an Acer Aspire laptop (model number: AS5633QLMi) with a 15.4-inch screen. The screen had a resolution of 98 pixels per inch (PPI) and was set at a 60 hertz (Hz) refresh rate. Each trial contained one of the following face pairs: Angry-Neutral (Neutral-Angry); Happy-Neutral (Neutral-Happy); Neutral-Neutral. A total of 32 Angry-Neutral trials and 32 Happy-Neutral trials were presented in a random order. Half of the trials displayed the emotional expression on the right and the other half displayed the emotional expression on the left. There were an equal number of congruent (i.e., where the probe appeared in the place of the emotive face) and incongruent trials (i.e., where the probe appeared in the place of the neutral face), resulting in eight critical trial types [see Table 6.4]. In addition, 16 neutral trials served as a control resulting in 80 trials in total. The Neutral-Neutral face pairs were included to help differentiate between the different components of attentional bias for threat (i.e., facilitated engagement, impaired disengagement, avoidance, and tendency not to engage). They were utilised to examine whether differences in attentional bias were caused by *improved performance* on threatening/positive congruent trials or *impaired performance* on threatening/positive incongruent trials relative to Neutral-Neutral baseline reaction times (RTs) (see Koster et al., 2004 and Legerstee et al., 2009 for extended

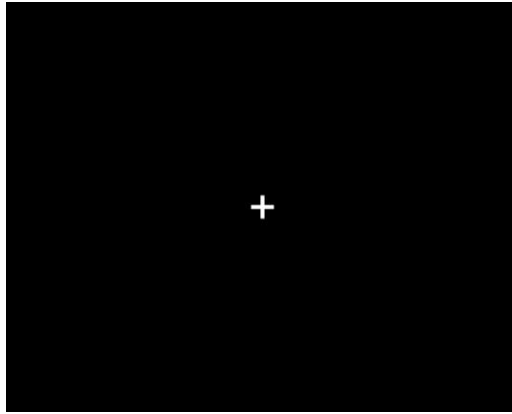
discussions). Incorporating Neutral-Neutral pairings also helped to reduce the frequency with which emotive stimuli appeared throughout the task.

Prior to the VP task, participants were told that they would be presented with pairs of faces followed by a star shape. They were also informed that they would be required to select which side of the screen the star appeared on. During the VP task, participants were seated approximately 60 cm from the screen. Trials began with a central fixation point that appeared on screen for 500 milliseconds (ms). This ensured that participants' gaze was directed at the centre of the screen before each face pair appeared. After 300 ms, the colour of the fixation point changed from white to red – this acted as a warning to participants that the faces were about to appear. Participants were informed that this would occur. On extinction of the fixation, a face pair was immediately presented for 200 ms. Face pairs were selected in a pseudorandom sequence generated by the experimental software. On extinction of the face pair, a probe (i.e., an asterisk) immediately appeared in one of the locations previously occupied by one of the face stimuli. This remained on-screen until the participant responded [see Figure 6.3 for an example of the VP task procedure].

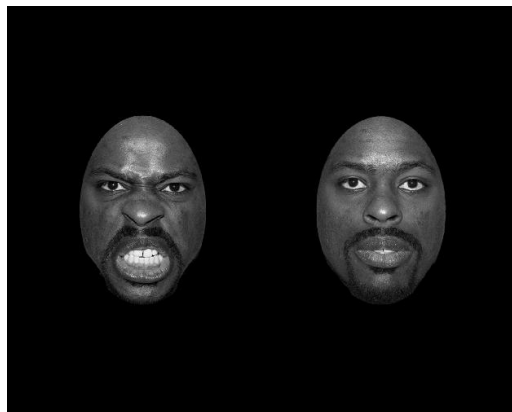
Table 6.4

Critical Trial Types in the Visual Probe Task

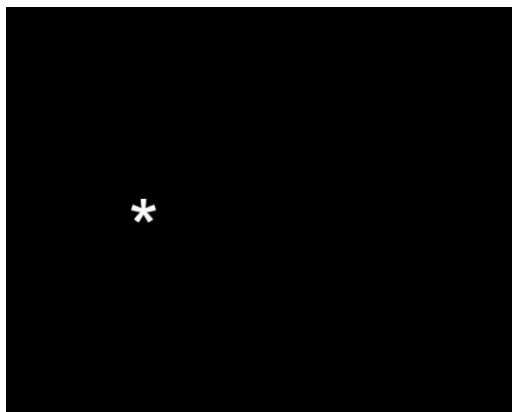
	<i>Congruent</i>	<i>Incongruent</i>
<i>Threatening</i>	Angry - Neutral	Angry - Neutral
	Neutral - Angry	Neutral - Angry
<i>Positive</i>	Happy - Neutral	Happy - Neutral
	Neutral - Happy	Neutral - Happy



A central fixation point appeared on the visual display for 500 ms.



Two faces (e.g., angry and neutral) appeared on the visual display for 200 ms.



A probe stimulus replaced one of the faces and remained on the visual display until the participant responded.

Figure 6.3 The visual probe task procedure.

Participants were required to select the location of the probe (i.e., left or right) by pressing an 'L' button on the left, or an 'R' button on the right, of a Cedrus RB-834 response pad. Location classification was utilised instead of probe type classification because: i) it requires fewer cognitive demands; and ii) it limits trial numbers required and thus overall task length, as one does not have to counterbalance the additional probe type factor (Garner, 2010). Participants were instructed to respond as quickly and as accurately as possible. The inter-trial interval varied randomly from between 750 and 1250 ms to prevent participants adopting a biased monitoring strategy. For example, participants could have time-locked motor responses as the task progressed, thus enabling them to favour one region of the display more than the other and simply determine the probe onset via its presence in, or absence from, the attended region (Garner, 2010).

Two example trials and ten practice trials were also presented at the beginning of the task. Example trials involved the experimenter demonstrating the task to participants utilising two actors that were not included in the experimental/control trials. During the practice trials, the experimenter monitored participants' responses and provided feedback in order to ensure that participants understood the task. RTs to probes and accuracy of responses were measured automatically by the Inquisit experimental software.

6.2.8 Subjective Appraisal Task

Findings from Investigation Three [see Chapter 4] demonstrated that high trait anxious (HTA), relative to low trait anxious (LTA), individuals were more accurate in identifying the neutral faces. Thus, in order to investigate this finding further, and the idea that such results (should they arise) reflect differences in interpretation biases based on anxiety levels, the final third of the current experiment involved asking participants to appraise their affective level for each face presented in the VP task. Since affect has been conceptualised along the two dimensions of arousal and valence (Russell, 1980; Lang, Greenwald, Bradley, & Hamm, 1993), a separate visual analogue scale (VAS; Hayes & Patterson, 1921) was utilised to measure levels of arousal and valence during the viewing of each face stimulus incorporated in the VP task. A VAS was included instead of a Likert scale (Likert, 1932) because it is more suitable for measuring constructs that are believed "*to range across a continuum of values and cannot easily be directly measured*" (Gould, Kelly, Goldstone, & Gammon, 2001, p. 706). It consisted of a continuous horizontal line, 100 mm in length, anchored by word descriptors at each end.

For the arousal task, participants were presented with each of the 24 faces from the VP paradigm and asked to indicate how nervous or relaxed each one made them feel. The VAS was presented beneath each face and included the descriptors ‘very nervous’ at the left anchor point and ‘very relaxed’ at the right anchor point [see Figure 6.4]. These terms were chosen based on the affective circumplex model (see Barrett & Russell, 1999), where ‘nervous’ represents high arousal (and negative affect), and the antonym ‘relaxed’ represents low arousal (and positive affect). Furthermore, the words ‘nervous’ and ‘relaxed’ are included in the STAI-C (Spielberger, 1973), which has been utilised successfully in both previous studies and the current PhD research. Participants indicated the point on the line that best represented their arousal level by moving a mouse cursor and clicking. Once participants had indicated their arousal level, the next face was displayed. Answers could range from 0% (very nervous) to 100% (very relaxed).

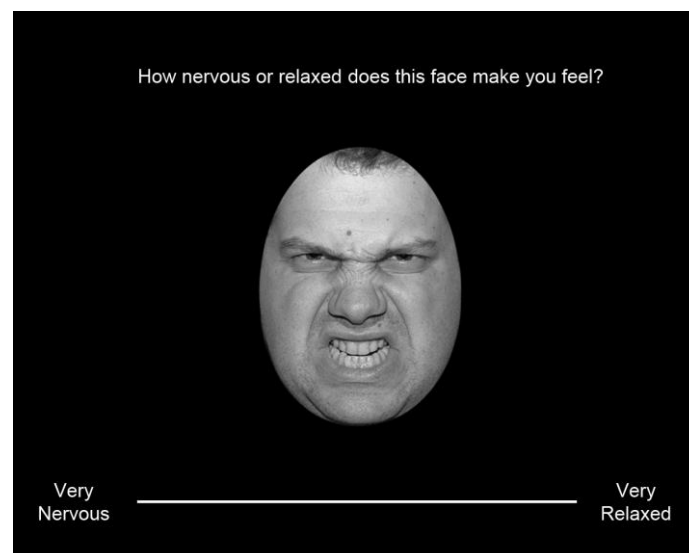


Figure 6.4 Example of a trial in the arousal visual analogue scale.

A similar process was repeated for the valence VAS task. This time, participants were asked to indicate how unpleasant or pleasant they felt each face looked. The valence scale included the descriptors ‘very unpleasant’ at the left anchor point and ‘very pleasant’ at the right anchor point [See Figure 6.5]. These terms were taken from the classic valence ratings commonly utilised with International Affective Picture System (IAPS) studies (e.g., see Lang et al., 1993). Answers could range from 0% (very unpleasant) to 100% (very pleasant).

In both VAS tasks, faces were presented in a random order for each participant. Each VAS task was presented in a separate block and consisted of 24 experimental trials (one for each face incorporated in the VP paradigm). Two dummy trials were also included at the beginning of each VAS task, which contained actors who were not utilised in the VP paradigm. This resulted in a total of 52 trials.

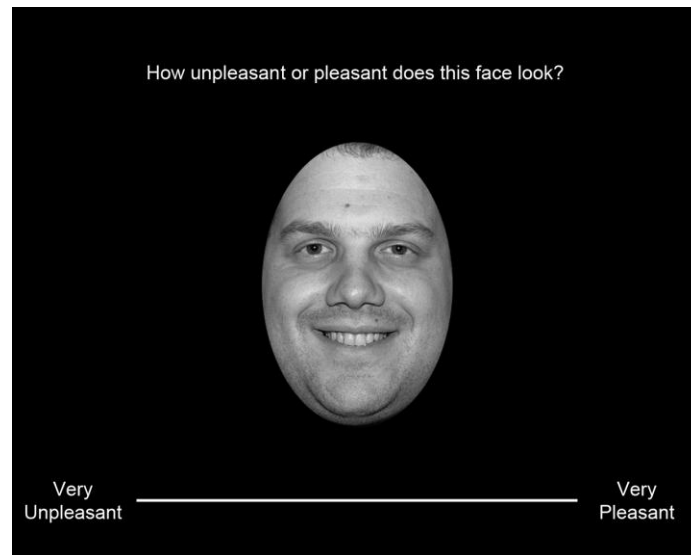


Figure 6.5 Example of a trial in the valence visual analogue scale.

In all, the experimental session took approximately 35 minutes: 15 minutes for the questionnaires; 10 minutes for the VP task; and 10 minutes for the VAS task. Participants were informed that they were allowed to have a break at any time and a structured short break was included half way through the VP task (i.e., after one block of experimental trials had been completed).

6.2.9 Data Preparation

One participant was excluded from data analysis due to non-completion of the VP task. A further participant was excluded due to poor performance on the VP task (i.e., greater than three standard deviations above the mean number of incorrect trials). This resulted in a final participant sample of 52 children (26 male; 26 female) aged between eight and eleven years ($M = 9.17$; $SD = .92$). These were 26 HTA (12 male, 14 female; age range = 8-11 years, M age = 9.0, $SD = 0.85$; M trait score = 43.92, $SD = 4.87$) and 26 LTA (13 male, 13 female; age range = 8-11 years, M age = 9.35, $SD = .98$; M trait score = 28.77, $SD = 2.73$) children.

An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(39.30) = -13.83, p < .001$].

For the purpose of the state anxiety analysis, participants were assigned to groups of high and low levels of state anxiety based upon their responses in the STAIC-S (Spielberger, 1973). This resulted in 27 high state anxious (HSA) (13 male, 14 female; age range = 8-11 years, M age = 9.26, $SD = 0.90$; M state score = 32.11, $SD = 4.73$) and 25 low state anxious (LSA) (12 male, 13 female; age range = 8-11 years, M age = 9.08, $SD = 0.95$; M state score = 23.80, $SD = 1.83$) children. An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than the LSA group [$t(34.07) = -8.47, p < .001$].

Data were screened so that RTs from trials with incorrect responses were excluded (6% of trials), as were RTs that were less than 200 ms ($< 1\%$ of trials) or greater than three standard deviations above each participant's mean (1.5% of trials). This is a common procedure in VP study analysis (e.g., Koster et al., 2005). During the subjective appraisal task, one participant did not complete the arousal scale and three participants did not complete the valence scale.

6.2.10 Data Analysis

RTs to probes were utilised to examine overall effects of congruency, valence and anxiety level in the initial analyses of trait and state anxiety. Attentional bias scores for threatening and positive trials were subsequently utilised to determine any interaction effects and to help differentiate between the components of attentional bias. These scores were calculated by employing the formula proposed by MacLeod and Mathews (1988), which involves subtracting the mean RT to a probe that replaces the emotive (i.e., angry or happy) face (i.e., a congruent trial) from the mean RT to a probe that replaces the neutral face (i.e., an incongruent trial). In this respect, the neutral stimulus acts as a baseline from which the RT for the emotive stimulus is subtracted [*see Figure 6.6 for an example of this calculation*]. This means that attentional bias scores will be positive if there is an attentional bias towards emotive stimuli (or an attentional bias away from neutral stimuli), and negative if there is an attentional bias away from emotive stimuli (or an attentional bias towards neutral stimuli). An attentional bias score of zero indicates an absence of attentional bias. Note that the neutral trials were not included in this analysis since they cannot be differentiated as being congruent or incongruent (Koster et al., 2004).

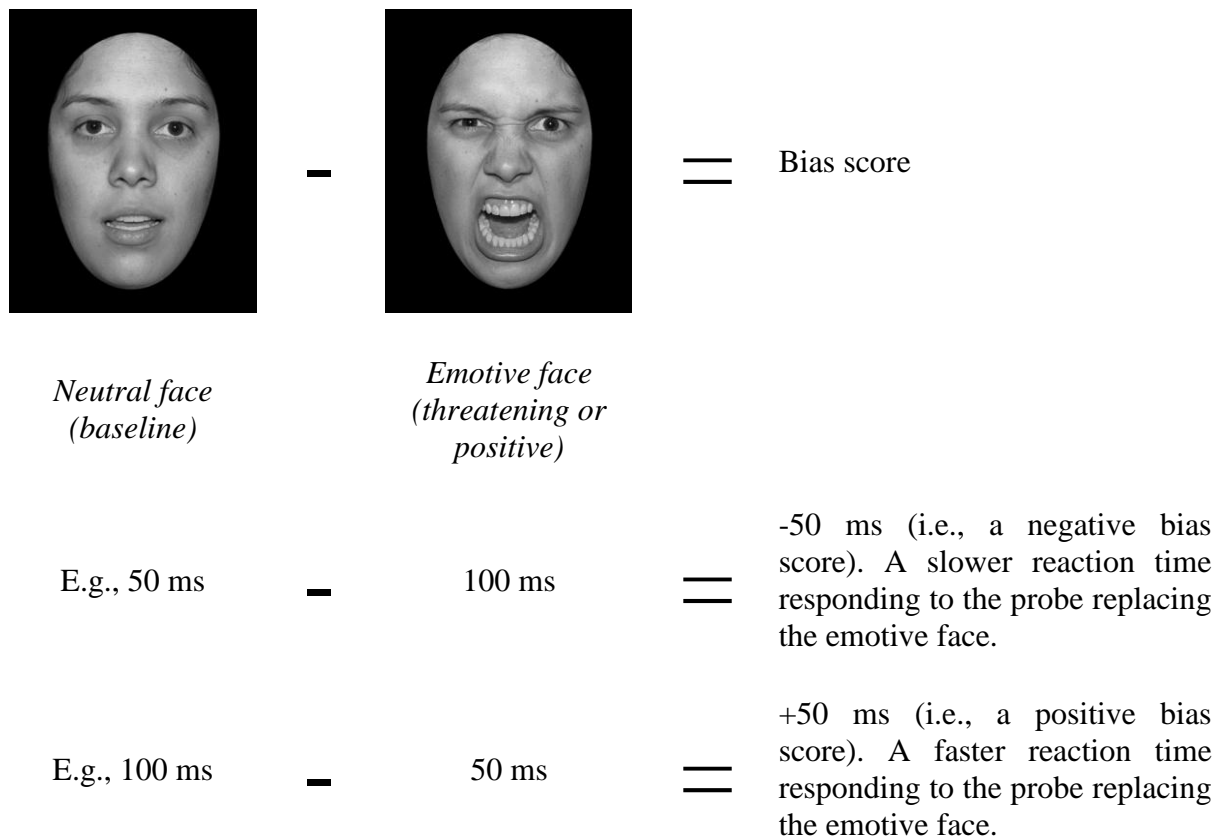


Figure 6.6 Example of how the attentional bias scores were calculated.

6.3 Results

6.3.1 Trait Anxiety Analysis

6.3.1.1 Reaction Time Data

Table 6.5 shows the mean RTs to probes during each trial type for both HTA and LTA participants. To examine the congruency effect, as suggested by Koster et al. (2004), RTs were subjected to a 2 X 2 X 2 mixed analysis of variance (ANOVA) with Trait Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for trait anxiety [$F(1, 50) = .86, p = .357; \eta_p^2 = .02$], valence [$F(1, 50) = .14, p = .706; \eta_p^2 = .00$] or congruency [$F(1, 50) = .09, p = .764; \eta_p^2 = .00$]. However, there were significant interactions between trait anxiety and valence [$F(1, 50) = 4.69, p = .035; \eta_p^2 = .09$] and trait anxiety, valence and congruency [$F(1, 50) = 4.09, p = .049; \eta_p^2 = .08$]. The

interaction effects between trait anxiety and congruency [$F(1, 50) = 1.51, p = .225; \eta_p^2 = .03$], and valence and congruency [$F(1, 50) = 2.32, p = .134; \eta_p^2 = .04$] did not reach statistical significance.

Table 6.5

Mean Reaction Times to Probes (with Standard Deviations in Parentheses) as a Function of Trait Anxiety, Valence and Congruency

	Angry		Happy		<i>Total</i>
	Congruent	Incongruent	Congruent	Incongruent	
High Trait Anxiety	457.81 (79.60)	481.83 (90.09)	493.50 (83.89)	476.83 (85.50)	482.60 (85.89)
Low Trait Anxiety	466.30 (66.92)	476.92 (77.30)	455.67 (71.33)	460.49 (67.62)	453.60 (74.72)
Total	462.06 (71.76)	479.38 (83.70)	474.59 (77.61)	468.66 (76.56)	
	470.72 (77.73)		471.63 (77.09)		

6.3.1.2 Attentional Bias Scores

In order to clarify the interaction effects, attentional bias scores were calculated for each trial type and participant utilising the formula proposed by MacLeod and Mathews (1988) [see section 6.2.10]. Mean attentional bias scores for angry and happy faces for the high and low trait anxious groups are presented in Table 6.6.

Table 6.6

Mean Attentional Bias Scores (with Standard Deviations in Parentheses) as a Function of Trait Anxiety and Valence

Valence	High Trait Anxiety	Low Trait Anxiety	<i>Total</i>
Angry	6.02 (29.45)	1.63 (35.70)	3.83 (32.58)
Happy	-16.66 (38.33)	4.82 (32.20)	-5.92 (35.27)
Total	-5.32 (33.89)	3.23 (33.95)	

To compare high and low trait anxious participants' attentional bias scores for angry and happy faces, two independent samples t-tests, with Trait Anxiety (high versus low) as the independent variable, were undertaken for threatening and positive trials separately.

For positive trials, results revealed that there was a significant difference in HTA and LTA participants' performance [$t(50) = 2.12, p = .033, d = 0.61$], such that HTA participants appeared to display an attentional bias away from happy faces ($M = -16.66, SD = 38.33$), whereas LTA participants appeared to display an attentional bias towards happy faces ($M = 4.82, SD = 32.20$) [see Figure 6.7]. To investigate this finding further, difference from zero was also assessed (see Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). That is, one-sample t-tests were conducted for both HTA and LTA children by comparing their mean attentional bias scores to "0", (the theoretical *non-bias* score reference point). An attentional bias score of "0" represents equal reaction times to invalid and valid trials, thereby indicating *no* bias toward or away from either stimulus type. It was found that the attentional bias score for happy faces differed significantly from zero in the HTA group [$t(25) = -2.22, p = .036, d = 0.87$] but not in the LTA group [$t(25) = .76, p = .453, d = 0.30$].

For threatening trials, there was no significant difference in HTA and LTA participants' performance [$t(50) = -.48, p = .630, d = 0.13$].

Finally, to investigate any within subject effects, two repeated measures t-tests of attentional bias scores, with Trial Type (threatening versus positive) as the independent variable, were undertaken for HTA and LTA participants separately.

For HTA participants, results revealed that there was a significant difference in attentional bias scores for angry versus happy faces [$t(25) = 2.43, p = .023, d = 0.67$], with participants appearing to display an attentional bias away from happy faces ($M = -16.66, SD = 38.33$) and an attentional bias towards angry faces ($M = 6.02, SD = 29.45$). In addition and as reported above, HTA participants' negative attentional bias score for happy faces differed significantly from zero. However, their positive attentional bias score for angry faces did not [$t(25) = 1.04, p = .307, d = 0.41$].

For LTA participants, there was no significant difference in attentional bias scores for angry versus happy faces [$t(25) = -.364, p = .719, d = 0.09$].

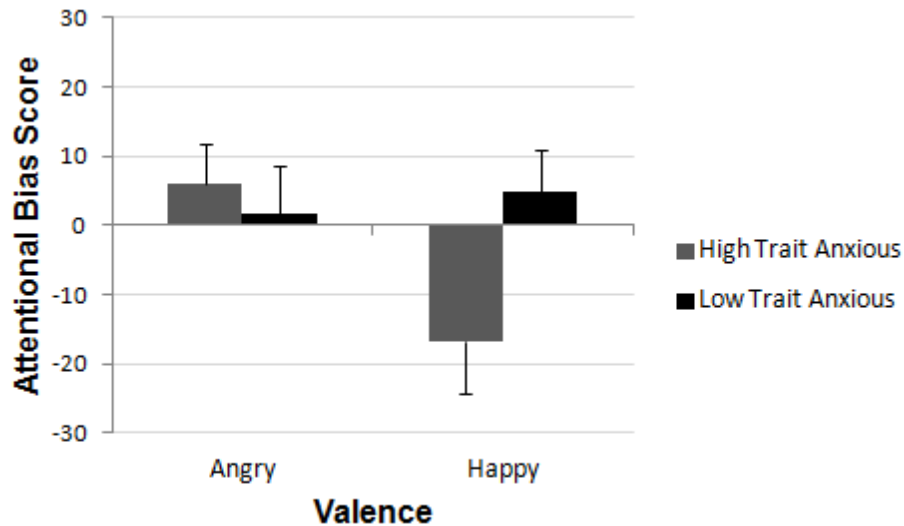


Figure 6.7 Attentional bias scores as a function of trait anxiety and valence. Error bars represent standard errors of the mean

6.3.1.3 Components of Attentional Bias

The previous analyses revealed a negative attentional bias score for happy faces in HTA participants. In order to determine whether this effect was due to avoidance of, *or* tendency not to engage attention with, happy faces, congruent and incongruent positive trials were compared with neutral trials in HTA participants, respectively. For these two analyses, repeated measures t-tests of reaction times were conducted separately for each congruency.

For congruent positive trials, results revealed that there was no significant difference in how HTA participants responded to happy faces ($M = 493.50$, $SD = 83.89$, $SE = 16.45$) compared with neutral faces ($M = 485.01$, $SD = 90.38$, $SE = 17.73$) [$t(25) = 1.03$, $p = .314$, $d = 0.10$]. For incongruent positive trials, there was no significant difference in how HTA participants responded to happy faces ($M = 476.83$, $SD = 85.50$, $SE = 16.77$) compared with neutral faces [$t(25) = -1.17$, $p = .251$, $d = 0.10$]. These results suggest that both components of attentional bias (i.e., avoidance of and tendency not to engage attention with) played an equally important role in the overall effect of attentional bias away from happy faces.

6.3.1.4 Attentional Control and Trait Anxiety

Table 6.7 shows the number of participants that were either high or low in levels of trait anxiety and either high or low in levels of AC.

Table 6.7

Frequency of Participants as a Function of Trait Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)

	High Trait Anxiety	Low Trait Anxiety	Total
High Attentional Control	9	18	27
Low Attentional Control	17	8	25
Total	26	26	

A 2 X 2 chi-square analysis revealed that there was a significant association between anxiety level and AC level [$\chi^2(1, N = 52) = 6.24, p = .012$]. That is, HTA was associated with low AC, and LTA was associated with high AC. Cramer's V was found to be 0.35, thus nearly 12% of the variation in frequencies of trait anxiety can be explained by AC.

Since results suggest a bias away from positive, relative to threatening, stimuli in HTA children, there was no rationale to conduct further analyses. This is because AC is thought to be associated with attentional bias for *threat* (Eysenck et al., 2007) and in particular, *impaired disengagement* from threat (Cisler & Koster, 2010).

6.3.2 State Anxiety Analysis

6.3.2.1 Reaction Time Data

To examine the congruency effect, RTs were subjected to a 2 X 2 X 2 mixed ANOVA with State Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for state anxiety [$F(1, 50) = .866, p = .357; \eta_p^2 = .02$], valence [$F(1, 50) = .167, p = .685; \eta_p^2 = .00$] or congruency [$F(1, 50) = .105, p = .747; \eta_p^2 = .00$]. Furthermore, the interaction effects between state anxiety and valence [$F(1, 50) = 1.18, p = .282; \eta_p^2 = .02$], state anxiety and congruency [$F(1, 50) = .499, p = .499; \eta_p^2 = .01$], valence and congruency [$F(1, 50) = 2.15, p = .149; \eta_p^2 = .04$], and state anxiety, valence, and congruency [$F(1, 50) = .01, p = .922; \eta_p^2 = .00$] did not reach statistical significance. Given that there was no effect of congruency, no further analyses were conducted (see Koster et al., 2004).

6.3.2.2 Attentional Control and State Anxiety

Table 6.9 shows the number of participants that were either high or low in levels of state anxiety and either high or low in levels of AC.

Table 6.8

Frequency of Participants as a Function of State Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)

	High State Anxiety	Low State Anxiety	Total
High Attentional Control	9	18	27
Low Attentional Control	18	7	25
Total	27	25	

A 2 X 2 chi-square analysis revealed that there was a significant association between anxiety level and AC level [$\chi^2 (1, N = 52) = 7.78, p = .005$]. That is, HSA was associated with low AC, and LSA was associated with high AC. Cramer's V was found to be 0.39, thus approximately 15% of the variation in frequencies of state anxiety can be explained by AC.

Given that AC is thought to be associated with attentional bias for *threat* (Eysenck et al., 2007) and in particular, *impaired disengagement* of threat (Cisler & Koster, 2010), no further analyses were undertaken.

6.3.3 Subjective Appraisal and Trait Anxiety

6.3.3.1 Arousal Analysis

Table 6.10 shows the mean subjective arousal ratings for each face type in high and low trait anxious participants.

To investigate the effects of trait anxiety and face type on arousal ratings, a mixed ANOVA was carried out with Trait Anxiety (high [$N = 25$] versus low [$N = 26$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was arousal ratings, where 0% = 'very nervous' and 100% = 'very relaxed'. Results revealed that there was a main effect for face type [$F(2, 98) = 240.06, p < .001, \eta_p^2 = .83$] but not for trait anxiety [$F(1, 49) = 1.25, p =$

.269, $\eta_p^2 = .03$]. The interaction effect between trait anxiety and face type did not reach statistical significance [$F(2, 98) = .306, p = .737, \eta_p^2 = .01$].

For the main effect of face type, pair-wise Bonferroni corrected comparisons revealed lower ratings for angry faces ($M = 18\%$, $SD = 13\%$) compared with neutral faces ($M = 51\%$, $SD = 14\%$; $p < .001, d = 2.44$) and happy faces ($M = 77\%$, $SD = 14\%$; $p < .001, d = 4.37$). Findings further revealed lower ratings for neutral faces compared with happy faces ($p < .001, d = 1.86$) [see Figure 6.8].

Table 6.9

Mean Arousal Ratings (with Standard Deviations in Parentheses) as a Function of Trait Anxiety and Face Type

	Angry	Neutral	Happy	Total
High Trait	20% (15%)	53% (16%)	77% (11%)	50% (14%)
Low Trait	16% (11%)	50% (11%)	77% (16%)	48% (13%)
Total	18% (13%)	51% (14%)	77% (14%)	

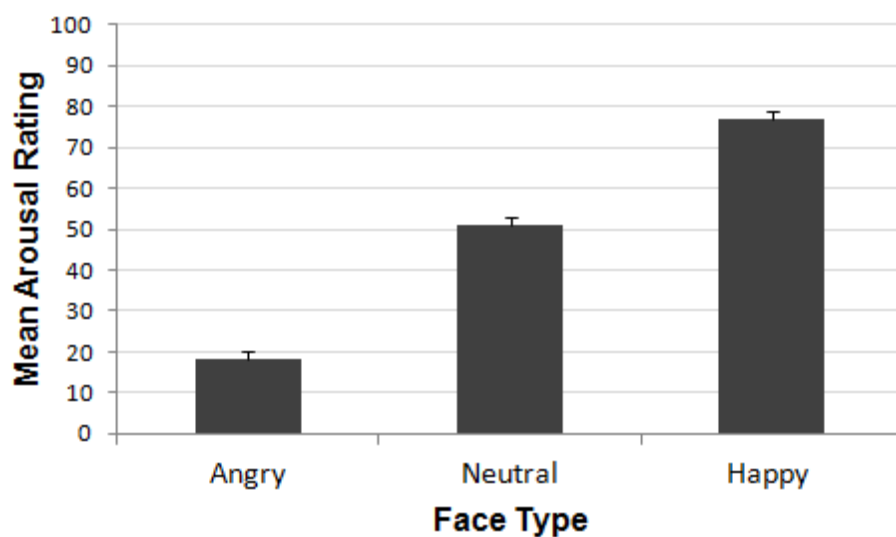


Figure 6.8 The effect of face type on mean arousal ratings. Error bars represent standard errors of the mean.

6.3.3.2 Valence Analysis

Table 6.11 shows the mean subjective valence ratings for each face type in high and low trait anxious participants.

Table 6.10

Mean Percentage of Valence Ratings (with Standard Deviations in Parentheses) as a Function of Trait Anxiety and Face Type

	Angry	Neutral	Happy	Total
High Trait	12% (8%)	49% (15%)	80% (13%)	47% (12%)
Low Trait	8% (6%)	44% (10%)	84% (13%)	45% (10%)
Total	10% (7%)	47% (13%)	82% (13%)	

To investigate the effects of trait anxiety and face type on valence ratings, a mixed ANOVA was carried out with Trait Anxiety (high [$N = 24$] versus low [$N = 25$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was valence ratings, where 0% = ‘very unpleasant’ and 100% = ‘very pleasant’. Results revealed that there was a main effect for face type [$F(2, 94) = 589.54, p < .001, \eta_p^2 = .93$] but no main effect for trait anxiety [$F(1, 47) = .43, p = .517, \eta_p^2 = .01$]. The interaction effect between trait anxiety and face type demonstrated a trend towards significance [$F(2, 94) = 2.70, p = .072, \eta_p^2 = .05$] [see Figure 6.9].

For the main effect of face type, pair-wise Bonferroni corrected comparisons revealed lower ratings for angry faces ($M = 10\%$, $SD = 7\%$) compared with neutral faces ($M = 47\%$, $SD = 13\%$; $p < .001, d = 3.7$) and happy faces ($M = 82\%$, $SD = 13\%$; $p < .001, d = 7.2$). Findings further revealed lower ratings for neutral faces compared with happy faces ($p < .001, d = 2.69$).

To investigate the marginally significant interaction between trait anxiety and face type, independent samples t-tests, with Trait Anxiety (high versus low) as the independent variable were undertaken for each face type separately. For angry faces, results revealed that there was a trend towards a significant difference in HTA and LTA participants’ valence ratings [$t(47) = -1.91, p = .063, d = 0.57$], such that HTA participants’ ratings were marginally higher ($M = 12\%$, $SD = 8\%$) than those of LTA participants ($M = 8\%$, $SD = 6\%$).

There were no significant differences in HTA and LTA participants' valence ratings for happy [$t(47) = 1.29, p = .202, d = 0.31$] or neutral faces [$t(47) = -1.64, p = .108, d = 0.40$].

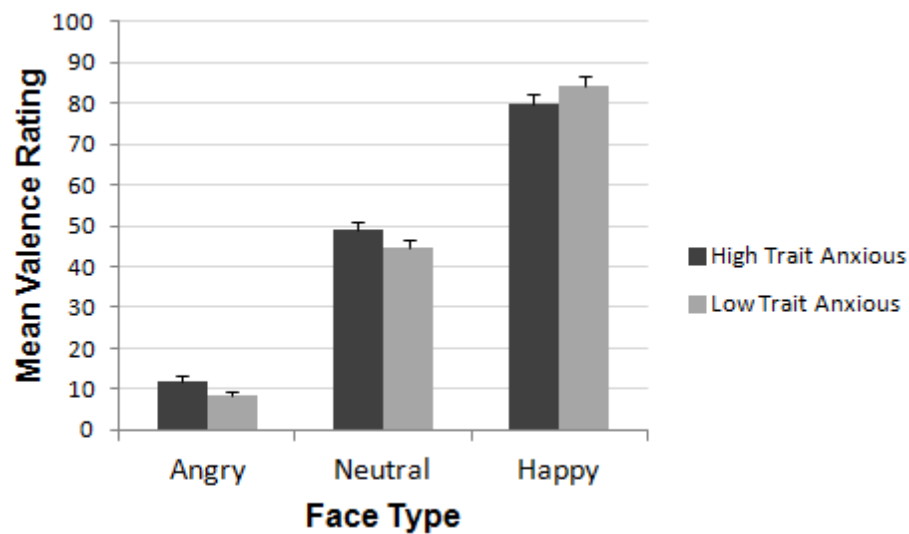


Figure 6.9 The effects of trait anxiety and face type on mean valence ratings. Error bars represent standard errors of the mean.

6.3.4 Subjective Appraisal and State Anxiety

6.3.4.1 Arousal Analysis

Table 6.12 shows the mean subjective arousal ratings for each face type in high and low state anxious participants.

Table 6.11

Mean Arousal Ratings (with Standard Deviations in Parentheses) as a Function of State Anxiety and Face Type

	Angry	Neutral	Happy	Total
High State	19% (14%)	49% (11%)	74% (14%)	47% (13%)
Low State	17% (13%)	54% (16%)	80% (13%)	50% (14%)
Total	18% (14%)	52% (14%)	77% (14%)	

To investigate the effects of state anxiety and face type on arousal ratings, a mixed ANOVA was carried out with State Anxiety (high [$N = 26$] versus low [$N = 25$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was arousal ratings, where 0% = ‘very nervous’ and 100% = ‘very relaxed’. Results revealed that there was a main effect for face type [$F(2, 98) = 245.89, p < .001, \eta_p^2 = .83$] but not for state anxiety [$F(1, 49) = 2.00, p = .163, \eta_p^2 = .04$]. The interaction effect between state anxiety and face type did not reach statistical significance [$F(2, 98) = 1.30, p = .277, \eta_p^2 = .03$].

For the main effect of face type, pair-wise Bonferroni corrected comparisons revealed lower ratings for angry faces ($M = 18\%$, $SD = 14\%$) compared with neutral faces ($M = 52\%$, $SD = 14\%$; $p < .001, d = 2.43$) and happy faces ($M = 77\%$, $SD = 14\%$; $p < .001, d = 4.21$). Findings further revealed lower ratings for neutral faces compared with happy faces ($p < .001, d = 1.79$).

6.3.4.2 Valence Analysis

Table 6.13 shows the mean subjective valence ratings for each face type in high and low state anxious participants.

Table 6.12

Mean Percentage of Valence Ratings (with Standard Deviations in Parentheses) as a Function of State Anxiety and Face Type

	Angry	Neutral	Happy	Total
High State	11% (7%)	45% (11%)	77% (14%)	44% (11%)
Low State	9% (7%)	49% (11%)	88% (9%)	49% (9%)
Total	10% (7%)	47% (11%)	83% (12%)	

To investigate the effects of state anxiety and face type on valence ratings, a mixed ANOVA was carried out with State Anxiety (high [$N = 25$] versus low [$N = 24$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was valence ratings, where 0% = ‘very unpleasant’ and 100% = ‘very pleasant’. Results revealed that there was a main effect for state anxiety [$F(1, 47) = 6.72, p = .013, \eta_p^2 = .13$] and face type [$F(2, 94) = 627.37, p <$

.001, $\eta_p^2 = .93$]. There was also a significant interaction between state anxiety and face type [$F(2, 98) = 5.57, p = .005, \eta_p^2 = .12$] [see Figure 6.10].

To clarify the interaction, independent samples t-tests, with State Anxiety (high versus low) as the independent variable were undertaken for each face type separately. There was a significant difference in how HSA and LSA participants' rated happy faces [$t(47) = 3.40, p = .001, d = 0.92$], such that HSA participants' ratings were lower ($M = 77\%, SD = 14\%$) than those of LSA participants ($M = 88\%, SD = 9\%$). There were no significant differences in HSA and LSA participants' valence ratings for angry [$t(47) = -1.13, p = .202, d = 0.29$] or neutral faces [$t(47) = 1.28, p = .209, d = 0.36$].

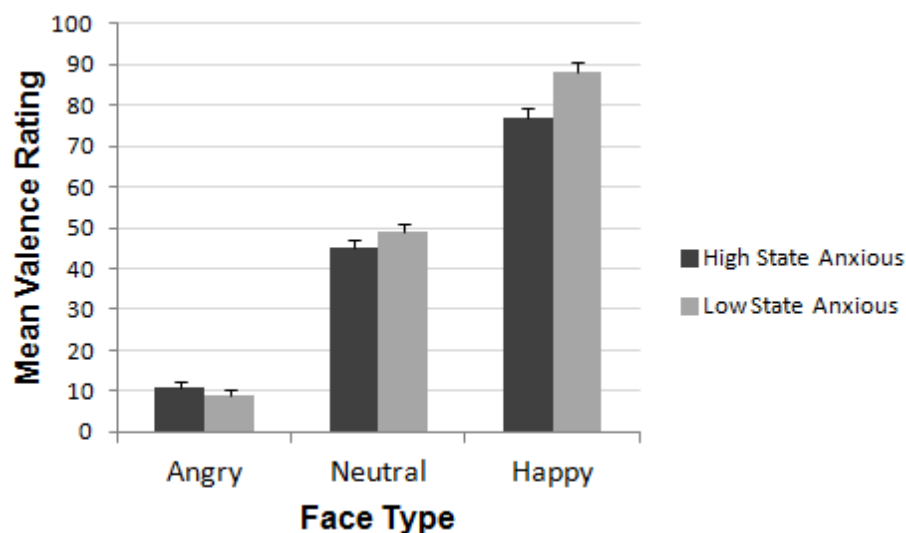


Figure 6.10 The effects of state anxiety and face type on mean valence ratings. Error bars represent standard errors of the mean.

6.4 Discussion

The main aim of the present research was to investigate the effects of anxiety on covert attention for angry, relative to happy and neutral facial expressions in a child population. A further aim was to determine the specific component(s) of attentional bias. Findings demonstrated that HTA children, in comparison to LTA children, biased their attention away from happy faces. It was further found that HTA children biased their attention away from happy faces relative to angry faces. In relation to these findings, it was demonstrated that this attentional bias equally consisted of a tendency not to engage attention towards, and avoidance of, happy faces. Subjective appraisal data showed that all children

gave the lowest ratings (i.e., ‘very unpleasant’) for angry faces and the highest ratings (i.e., ‘very pleasant’) for happy faces on the valence scale. In addition, findings demonstrated that HTA children rated the angry faces as being marginally more pleasant than did LTA children. Furthermore, HSA children rated the happy faces as being significantly less pleasant than did the LSA children. In regards to the arousal scale, findings showed that all children gave the lowest ratings (i.e., ‘very nervous’) for angry faces and the highest ratings (i.e., ‘very relaxed’) for happy faces. A further finding was that levels of state and trait anxiety were associated with levels of AC.

Findings suggest that eight to eleven year old children with high levels of trait anxiety display both a propensity to avoid happy faces as well as not engage attention with them by diverting attention towards other spatial locations. This finding of an attentional bias away from *happy* faces in HTA children is unexpected [*see hypothesis i), section 6.1*] since it is inconsistent with all previous child VP studies in the area. This past research has either demonstrated an attentional bias towards or away from *threatening* (e.g., angry or fearful) stimuli, relative to neutral and/or positive stimuli, or a bias away from threatening stimuli in both clinically and non-clinically anxious populations (Brotman et al., 2007; Heim-Dreger et al., 2006; Hunt et al., 2007; Legerstee et al., 2009; Monk et al., 2006; Pine et al., 2005; Roy et al., 2008; Stirling et al., 2006; Taghavi et al., 2003; Taghavi et al., 1999; Telzer et al., 2008; Vasey et al., 1995; Waters et al., 2004; Waters et al., 2008; Waters et al., 2010). That said, this previous child literature has focused exclusively on the role of *overt* attention, whereas the current study appears to be the first to test the effects of anxiety on covert spatial attention in children.

In relation to the adult research, the present findings still offer no support. This is the case for both adult VP studies of overt *and* covert attention, which have again revealed attentional bias for *threatening* compared with positive and neutral stimuli (for reviews, see Bar-Haim et al., 2007; Frewen et al., 2008). Of those studies that have disentangled the components of attentional bias, facilitated engagement to threat has been shown for threatening stimuli presented within the time period required for measuring covert attention (e.g., 100 ms - Carlson & Reinke, 2008; Koster, Verschuere, Crombez, & Van Damme, 2005).

Although the current data does not accord with the majority of previous VP studies investigating anxiety, it does offer support for research relating to *social anxiety*, which suggests that individuals with high levels of social anxiety, relative to those with low social

anxiety: i) take longer to recognise positive facial expressions (e.g., Silvia, Allan, Beauchamp, Maschauer, & Workman, 2006); ii) are worse at detecting positive cues from audience members during speech tasks (Perowne & Mansell, 2002; Veljaca & Rapee, 1998); and iii) interpret positive social events as negative, thus heightening anxiety levels (e.g., Alden, Taylor, Mellings, & Laposa, 2008; Wallace & Alden, 1997). Of particular relevance, some adult VP studies have demonstrated an association between social phobia and a tendency to preferentially allocate attention away from positive stimuli (Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, Ehlers, & Chen, 1999; Pishyar, Harris, & Menzies, 2004; Taylor, Bomyea, & Amir, 2010). For instance, Mansell and colleagues (1999) presented high and low socially anxious participants with picture pairs, which consisted of a face (either happy, negative or neutral) and a household object. The results demonstrated that high, relative to low, socially anxious individuals displayed an attentional bias away from both happy and negative faces. In addition, research into the effects of cognitive behavioural therapy on social anxiety disorder has demonstrated that successful treatment leads to a reversal in the attentional bias away from happy facial expressions, such that individuals display an attentional bias towards these faces instead (Pishyar, Harris, & Menzies, 2008).

One explanation for the present finding and those in relation to social anxiety may be that happy faces are suggested to signify social dominance, which could result in the viewer experiencing feelings of subordination (Hess, Adams, & Kleck, 2005; Hess, Blairy, & Kleck, 2000; Heuer, Rinck, & Becker, 2007; Schultheiss & Hale, 2007; Schultheiss, Pang, Torges, Wirth, & Treynor, 2005). According to Heuer et al. (2007), socially anxious individuals and those who hold negative beliefs about themselves may exhibit avoidance and submission to a smiling individual because this facial expression is interpreted as a sign of social dominance. It is argued that avoidance of such stimuli may reflect defensive efforts to reduce levels of anxiety (Berenson et al., 2009). In agreement, Schultheiss et al. (2005) found that whilst happy faces are judged to be high in affiliation and friendliness, they are also high in dominance and can symbolise social rank, thus leading to the recipient feeling subordinate.

Alternatively, it could be that both socially anxious individuals and children with a tendency to develop anxiety interpret the faces as mocking (Bradley et al., 1999; Vrticka, Andersson, Grandjean, Sander, & Vuilleumier, 2008; Yoon & Zinbarg, 2007) or that the smiles signify social approach, which may be threatening to those who fear social interaction, such as socially anxious individuals (Bradley et al., 1999; Campbell et al., 2009; Heuer et al., 2007; Rapee & Heimberg, 1997). Although these explanations have previously been applied

to social anxiety, it could be that they expand to childhood anxiety in general. That is, children with a tendency to develop an anxiety disorder may interpret happy faces as threatening due to the reasons outlined above and hence bias their attention away from them.

The subjective appraisal data does not support hypothesis ii) since it demonstrated that arousal ratings were lowest for angry faces and highest for happy faces, irrespective of anxiety level. This suggests that angry faces made all children feel the most nervous whilst happy faces made all children feel the most relaxed. As there were no significant differences in how high and low trait anxious participants responded with regard to both the subjective valence and arousal scale ratings, this would suggest that the results obtained in the VP experiment reflect covert/subconscious differences in how HTA children appraise happy faces. This, therefore, is an important area for future research, especially since it was found that children with higher levels of state anxiety rated the happy faces as less pleasant than did the LSA children. Also, worthy of note is that the neutral faces were consistently rated within the midpoint of the scale (i.e., 44-55%) and therefore, it can be argued that this stimulus type is interpreted by children as neutral rather than threatening [*see Chapter 4, section 4.4*].

Finally, the theory that AC modulates the relationship between anxiety and attentional bias for threat (Eysenck et al., 2007) was not investigated in the present study because findings did not reveal impaired disengagement in relation to angry faces. However, it was found that anxiety and AC were associated with each other, such that HTA and HSA children typically demonstrated lower levels of AC, whilst LTA and LSA children typically demonstrated higher levels of AC. This accords well with Eysenck et al.'s (2007) assumption that higher levels of anxiety decrease the two functions of executive control associated with AC: attentional inhibition / focusing and shifting. Thus, it may be the case that higher levels of anxiety: i) reduce the degree to which inhibitory mechanisms are able to regulate automatic responses; and ii) increase the degree to which attention is shifted from one task to another. Future research should include measures of AC to both replicate the present findings and to test whether AC is also associated with attentional bias for threat, should any threat-related findings emerge.

To conclude, findings from the current investigation suggest that eight to eleven year old children with high, relative to low, levels of trait anxiety display covert biases of attention away from happy faces compared with angry faces. This is in accordance with research relating to social anxiety, which implies that those with high levels of social anxiety interpret happy faces as threatening and thus avoid them. Given that there were no differences in how

HTA and LTA participants rated the faces in terms of valence and arousal, one suggestion is that the observed differences reflect covert/subconscious differences in how HTA children appraise happy faces.

CHAPTER 7

Investigation Six: Eye Movements and the Time Course of Overt Attentional Bias for Emotive Stimuli during the Visual Probe Task

7.1 Introduction

Main findings from the previous visual probe (VP) investigation [*see Chapter 6*] suggest that high trait anxious (HTA), relative to low trait anxious (LTA), children aged between eight and eleven years old display an attentional bias away from happy faces during covert orienting. More specifically, these children have a tendency not to engage attention with happy faces and/or to avoid happy faces by diverting attention towards other spatial locations. In addition, findings imply that this attentional bias away from happy faces in HTA children is relative to angry faces. However, this former study only examined *covert* spatial attention utilising a stimulus exposure duration of 200 milliseconds (ms). As such, it is also necessary to examine *overt* spatial attention by incorporating longer stimulus presentation times. This will provide a more comprehensive understanding of the components of attentional bias and how they vary over time in relation to the development of anxiety.

As highlighted in the preceding chapter [*see section 6.1*], the majority of adult VP studies investigating the effects of anxiety on emotive stimuli have incorporated a stimulus exposure duration of 500 ms (for a review, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). According to Kowler, Anderson, Doshier, and Blaser (1995), this time period allows for one or more shifts in observable eye fixations to occur. That is, it allows for the measurement of conscious, overt spatial attention. Typically, these adult studies have shown that anxious participants respond faster to probes that replace threatening compared with neutral typographical/pictorial stimuli (for reviews, see Bar-Haim et al., 2007; Frewen, Dozois, Joanisse, & Neufeld 2008). This attentional bias towards threat has been evidenced in both clinical (generalised anxiety disorder - e.g., Bradley, Mogg, White, Groom, & de Bono, 1999; social anxiety disorder - e.g., Mogg, Phillipott, & Bradley, 2004) and non-clinical anxiety (e.g., Bradley, Mogg, Falla, & Hamilton, 1998; Ioannou, Mogg, & Bradley, 2004; Mogg & Bradley, 1999).

To a lesser extent, the 500 ms exposure duration has also been utilised in child populations. In relation to word stimuli, findings generally accord with adult data, demonstrating that anxious, relative to non-anxious children display an attentional bias towards threatening words (e.g., Hunt, Keogh, & French, 2007; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999; Vasey, Daleiden, Williams, & Brown, 1995). Yet, child research involving pictorial stimuli is currently mixed. For standardised affective pictures, findings have shown both an attentional bias towards (Waters, Lipp, & Spence, 2004; Waters, Wharton, Zimmer-Gembeck, & Craske, 2008), *and* an attentional bias away from (Legerstee et al., 2009), threatening images in anxious children. Research incorporating emotive facial expressions has demonstrated a similar pattern for threatening faces (attentional bias towards - Brotman et al., 2007; Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006; Monk et al., 2006; Roy et al., 2008; Telzer et al., 2008; Waters, Kokkoris, Mogg, Bradley, & Pine, 2010; attentional bias away from - Monk et al., 2008; Pine et al., 2005; Stirling, Eley, & Clark, 2006). Thus, it is necessary to conduct further research in an attempt to clarify these equivocal findings.

For longer durations (e.g., 1000 ms plus), an attentional bias away from threatening stimuli has also been observed in adult populations (1250 ms - Koster, Verschuere, Crombez, & Van Damme, 2005; 1500 ms - Mogg, Bradley, Miles, & Dixon, 2004). These studies into the time course of attentional bias have involved modifying the VP task to include both intermediate (i.e., 500 ms) and long (e.g., 1500 ms) stimulus presentation times, which are thought to reflect earlier and later stages of attentional processing (Gamble & Rapee, 2009). For example, Koster and colleagues (2005) presented highly threatening (e.g., a mutilated body) and mildly threatening (e.g., a man with a knife) pictures for either 500 or 1250 ms. Results revealed that HTA, relative to LTA, participants displayed an attentional bias towards mildly threatening stimuli at the intermediate presentation time of 500 ms. Yet at longer durations (i.e., 1250 ms), these individuals attended away from both mildly and highly threatening pictures. Similar findings have also been observed in the exogenous cueing (Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006) and visual search (Pflugshaupt et al., 2005) paradigms.

However, some VP research has failed to demonstrate this effect among anxious adults, with results showing either an attentional bias towards threatening stimuli presented at *both* intermediate and long exposure durations (500 ms and 1250 ms - Bradley et al., 1999; 500 ms and 1500 ms - Mogg, Bradley, de Bono, & Painter, 1998) or an *initial* attentional bias

towards threat with *no* subsequent later attentional bias (500 ms and 1250 ms - Bradley et al., 1998; initial eye movements and 1000 ms - Mogg, Millar, & Bradley, 2000; 500 ms and 1250 ms - Mogg, Phillipott, & Bradley, 2004). As suggested by Cisler and Koster (2010), future research is therefore required to clarify these inconsistencies.

Due to the finding that different components of attentional bias may depend on the stage of information processing, researchers have considered more comprehensive models of attentional bias and anxiety that propose a variation in the direction of attention (Mogg & Bradley, 1998; Mogg et al., 1997; Mogg, Mathews, & Weinman, 1987). For instance, according to Mogg and Bradley's (1998) 'cognitive-motivational model', facilitated engagement and avoidance are both related to anxiety but occur in a temporally ordered manner. More specifically, anxiety initially causes attention to be directed towards threat but subsequent detailed processing of this information is avoided in an attempt to reduce anxiety levels, a pattern of attentional allocation often referred to as the vigilance-avoidance theory. A limitation of this theory is that it is based on studies concerned with adults, perhaps because few studies to date have investigated the time course of attentional bias in anxious children.

A further limitation of the vigilance-avoidance theory is that it does not account for impaired disengagement from or a tendency not to engage with threat. As highlighted in the previous chapter [*see section 6.1*], much of the existing VP literature investigating anxiety and attentional bias has failed to determine the specific components of attentional bias. According to researchers, an attentional bias towards emotive stimuli may reflect either facilitated engagement with, *or* impaired disengagement from, such stimuli (Koster, Crombez, Verschuere, & De Houwer, 2004; Posner & Peterson, 1990; Salemink, van den Hout, & Kindt, 2007). Furthermore, an attentional bias away from emotive stimuli may indicate either avoidance of, *or* a tendency not to engage with, these stimuli (Legerstee et al., 2009). Consequently, methods to disentangle these components of attentional bias have recently been proposed [*see Chapter 6, section 6.1; and Table 6.1 for further details*].

Of the few studies that have attempted to disentangle the distinct components of an attentional bias towards threat, findings have demonstrated facilitated engagement towards threatening stimuli presented for short time periods (100 ms - Carlson & Reinke, 2008; Koster, Verschuere, Crombez, & Van Damme, 2005), but impaired disengagement from such stimuli presented for longer durations (e.g., 500 ms; Koster, Crombez, Verschuere, & De Houwer, 2006; Koster et al., 2004; Salemink et al., 2007). However, only the Koster et al.

(2005) study has utilised this methodology during the investigation of the time course of overt attentional bias. Furthermore, it appears that only one study to date has attempted to distinguish the distinct components involved in an attentional bias away from threat (Legerstee et al., 2009; see Chapter 6, section 6.1 for further details). That said, this study did not measure the time course of spatial attention. Thus, it appears that no previous adult or child VP study has investigated the time course of overt attentional bias utilising the methodology proposed by both Koster et al. (2004) *and* Legerstee et al. (2009) to disentangle all components.

Of further consideration is that the VP paradigm solely provides indices of attentional allocation during probe onset, that is, at a specified time point. This means that it does not provide information about the time-course of attentional allocation before or after the moment of measurement (In-Albon & Schneider, 2010). In consequence, the measure may not accurately reflect participants' initial attentional allocation. Moreover, the measure is not sensitive to any shifts in attention that may occur repeatedly throughout each trial. As such, it is beneficial to incorporate eye tracking (ET) technology since this provides a continuous measure of the exact position of eye gaze, making it one of the most direct methods of investigating overt attention (Bögels & Mansell, 2004). Furthermore, this method offers greater ecological validity (Caseras, Garner, Bradley, & Mogg, 2007), since the direction of gaze is closely linked to what one perceives (Aslin & McMurray, 2004). According to Garner (2010), ET is particularly appropriate for child research, given that reaction time (RT) data alone may not be sensitive to individual differences in this population.

ET provides measures of initial orienting (as reflected by the direction and latency of the first shift in gaze) and maintenance of attention (as indexed by the duration of gaze). Thus, this methodology is able to help determine whether participants initially attend to a particular stimulus type, remain fixed on a specific stimulus type, shift attention back and forth in an unstable manner (e.g., Garner, Mogg, & Bradley, 2006), or avoid stimuli at longer presentation times (Frewen et al., 2008). This makes ET an effective methodology for testing the vigilance-avoidance model (Mogg & Bradley, 1998; Mogg et al., 1997; Mogg et al., 1987).

To date, little research has utilised ET technology to assess the course of spatial attentional bias in anxiety. Of those studies that have, the majority have involved spider phobic adults and demonstrate support for the vigilance-avoidance theory (Rinck & Becker, 2006; Pflugshaupt et al., 2005). For example, Rinck and Becker (2006) found that spider-

fearful individuals, relative to non-anxious controls, presented with a two by two matrix of specific fauna (i.e., spiders, butterflies, cats, and dogs) spent more time looking at the spider pictures for the first 500 ms. From 1500 to 3000 ms, however, spider fearfuls, relative to controls, spent less time looking at the spider pictures.

Of those studies conducted utilising facial stimuli, however, the majority have only demonstrated partial support for the vigilance-avoidance model (vigilance - Horley, Williams, Gonsalvez, & Gordon, 2004; Mogg et al., 2000; Richards, Benson & Hadwin, unpublished, as cited in Donnelly, Hadwin, Menneer, & Richards, 2010; avoidance - Rohner, 2002). For example, Richards et al. (unpublished, as cited in Donnelly et al., 2010) investigated eye movements during visual search for photographs of angry, happy and neutral faces amongst inverted face distracters in adults with high levels of social anxiety. Findings showed that the initial eye movement to angry faces was more accurate compared with happy faces for high socially anxious individuals. The effect was found to be moderated by attentional control (AC), with the threat advantage emerging most clearly in those with high social anxiety and low AC. In a recent VP study, Garner et al. (2006) found evidence for both facilitated engagement and avoidance. Here, the researchers measured the eye movements of high and low socially anxious participants whilst they viewed pictures of faces over a time period of 1500 ms. It was revealed that high socially anxious participants were quicker to look at emotive faces but viewed these faces for a shorter time period than did the low socially anxious participants.

As highlighted by In-Albon and Schneider (2010), ET studies in this area with children are rare. To date, it appears that only two studies have measured eye movements to investigate the time course of attentional bias in anxious children. In one study, In-Albon, Kossowsky, and Schneider (2010) utilised ET methodology to assess attentional bias in children with separation anxiety disorder (SAD) relative to normal controls. Stimuli consisted of colour photographs depicting either arrival or departure situations between a child and its mother, which were presented for a total of 4000 ms. Findings did not show an initial bias but instead demonstrated that children with SAD looked more at the threatening (i.e., separation/departure related) stimuli after 1000 ms. Findings further demonstrated that children with SAD avoided looking at the threatening pictures after 2000 ms.

In a second study, clinically anxious and non-anxious seven to eleven year old children ($N = 39$) were presented with face pairs consisting of either negative (i.e., anger, disgust, fear, and sadness) and neutral expressions or positive (i.e., happy) and neutral

expressions for either 500 ms or 3000 ms. Results revealed a bias in initial orienting for the 500 ms condition, such that clinically anxious, relative to non-anxious, children directed their first fixation away from happy faces. For the 3000 ms condition, findings showed that all participants, irrespective of anxiety level, displayed a vigilance-avoidance pattern of attention for the negative expressions (Gamble & Rapee, 2009). A limitation of this study, however, is that the range of negative faces incorporated means that it is not possible to determine whether the effect demonstrated is in relation to the specific threat (i.e., angry) stimuli. Also, whilst only one positive facial stimulus was incorporated, four negative stimuli were utilised, thus adding an inherent methodological confound into the design.

Given that the literature in this area is both mixed and scant, it is necessary to conduct further research, particularly in child populations. Consequently, the current investigation utilised the VP task with ET technology to investigate the time course of spatial attention for angry and happy faces in children with a tendency towards anxiety. Stimulus exposure durations of 500 ms and 2000 ms were utilised to examine earlier and later stages of overt attentional processing, respectively. Hypotheses were formulated based on findings from previous VP studies of overt attention in adults. In regards to behavioural (i.e., RT) data, it was hypothesised that i) high state and/or trait anxious children would display an attentional bias towards (either facilitated engagement to or impaired disengagement from) angry, relative to happy and neutral faces at the 500 ms exposure. It was further predicted that ii) high state and/or trait anxious children would display an attentional bias away from (either avoidance of or a tendency not to engage with) angry, relative to happy and neutral faces at the 2000 ms exposure. In relation to ET data, it was hypothesised that iii) this would reveal an initial attentional bias towards angry faces in both the 500 ms and 2000 ms conditions for high anxious children. Furthermore, it was predicted that iv) children with high levels of anxiety would demonstrate a vigilance-avoidance pattern of attentional bias for angry faces in the 2000 ms condition.

Note also, since findings from Investigation Three [*see Chapter 4*] demonstrated that HTA, relative to LTA, children were more accurate in identifying neutral faces, the present investigation tested subjective appraisal of arousal and valence for each face type. It was hypothesised that v) there would be a difference in the valence and arousal ratings of neutral faces for high trait versus low trait anxious children.

Furthermore, the present investigation included the additional measure of AC since it has been posited that levels of anxiety interfere with an individual's ability to regulate

attentional allocation (Eysenck, Derakshan, Santos, & Calvo, 2007; see section 6.2.4.1 for further details). It was hypothesised that vi) any finding related to impaired disengagement from threat in high anxious children would be associated with low levels of AC.

Although two similar ET studies have successfully been conducted with eight to eleven year old children in the past (i.e., Gamble & Rapee, 2009; In-Albon et al., 2010), it was anticipated that the eye tracker would present particular challenges, especially for participants in the younger age group (i.e., Year 4). Therefore, the current investigation aimed to also test the feasibility of utilising ET methodology combined with a VP paradigm with children between the ages of eight and eleven years.

7.2 Methods

7.2.1 Pre-selection

A total of 307 children (156 male; 151 female) aged eight to eleven years ($M = 9.39$; $SD = 0.97$) were recruited from two local primary schools in Derbyshire, United Kingdom. Each of these schools received £50 worth of book vouchers for taking part. Participants undertook an initial pre-selection process, which involved completing the trait subscale of the State-Trait Anxiety Inventory for Children (STAIC-T; Spielberger, 1973) and the short version of the Children's Depression Inventory (CDI:S; Kovacs, 1992) [see Chapter 3, section 3.2.1.3 for descriptions]. Participants were then assigned to groups of high and low levels of trait anxiety utilising a tertile split, which resulted in approximately one third of the participants (i.e., those with medium levels of anxiety) being excluded. Mean ranking was utilised in the case of ties. In addition, participants who obtained a T-score of 65 or above on the CDI:S were deemed to be highly dysphoric and were subsequently excluded. Ethical approval was obtained from the University of Derby Psychology Research Ethics Committee.

7.2.2 Final Participants

Pre-selection resulted in a possible sample of 181 participants who were invited to take part in the experiment depending on the following selection criteria: i) normal vision; ii) English as the first language; and iii) free from developmental disorders and learning disabilities as reported by parents/guardians. This resulted in a final sample of 20 children (12 male; 8 female) aged eight to eleven years ($M = 9.70$; $SD = 0.86$), all of whom took part in the main experiment.

7.2.3 Stimuli

Stimuli were the same as those described in the previous visual probe (VP) study [see Chapter 6, section 6.2.3]. That is, they consisted of 24 facial expressions taken from the NimStim face set (Tottenham et al., 2009) and included angry, happy, and neutral faces [see Chapter 6, Figure 6.1 for an example] from eight actors of varying race. Sizes were altered for the present investigation since participants' viewing distance had changed with the investigation taking place in a campus laboratory. Therefore, each face measured ~4.8 X 7.1 cm and subtended visual angles of ~6.84 X 10.07 degrees when presented on the screen. Also, the distance between the centres of the faces (i.e., the nose tips) measured ~9 cm or rather, ~12.5 visual degrees. This is similar to previous VP studies in anxious children (e.g., Elam, 2010; Waters et al., 2008; Waters et al., 2010).

7.2.4 Self-Report Measures

In addition to the self-report measures utilised in the pre-selection process, the present investigation also included the state subscale of the STAIC (STAIC-S; Spielberger, 1973) [see Chapter 3, section 3.2.1.3.2 for a description] to measure for levels of state anxiety and the child version of the Attentional Control Scale (ACS-C; Muris, de Jong, & Engelen, 2004) [see Chapter 6, section 6.2.4.1 for a description] to measure for levels of attentional control (AC).

7.2.5 General Procedure

Based on the pre-selection process, participants with high or low levels of trait anxiety (and low levels of dysphoria) were invited to participate in the main experiment. This time, the experiment took place in a quiet room at the University of Derby due to the experiment involving a fixed eye tracker. As such, invitations were initially sent to parents/guardians and a suitable date and time was arranged for each participant and their carer(s) to visit the University. On arrival, one of the carers was required to provide informed, written consent for this phase of the research. Throughout the experiment, each participant always remained in view of their carer. Prior to data collection, the experimenter always provided the participant with a brief explanation of the research (with the opportunity to withdraw) and presented the consent form. The experiment consisted of the administration of both the STAIC-S (Spielberger, 1973) and the ACS-C (Muris et al., 2004), the VP task, and the subjective appraisal task. After the experiment, the child was thanked for taking part and

debriefed as to the purpose of the experiment. It was ensured that all participants understood the project and following participation, they were each rewarded with a £5 book token and a sticker for taking part. [See Appendix C for example covering letters, briefing/debriefing material and consent forms].

7.2.6 Administration of Self-Report Measures

During the experiment, participants were initially asked to complete the STAIC-S (Spielberger, 1973). The researcher asked each participant whether: i) they would like the experimenter to read each statement out loud to them and, in response, reply verbally and/or on paper; or ii) they were comfortable with reading the statements and answering on their own. Responses to the STAI-C were utilised to assign participants to groups of high and low levels of state anxiety after the experiment had taken place.

The ACS-C (Muris et al., 2004) was then administered. This was read out loud and participants were required to reply by marking their answers on the questionnaire. This questionnaire phase of the research took approximately 15 minutes.

7.2.7 Visual Probe Task

The VP task was programmed utilising Inquisit (www.millisecond.com) experimental software and was presented on a PC computer with a 15-inch screen. The screen had a resolution of 82 pixels per inch (PPI) and was set at a 60 hertz (Hz) refresh rate. Participants were tested individually and sat 40 cm away from the screen. The VP task proceeded as described in the previous VP study [see Chapter 6, section 6.2.7]. However, the present study incorporated two different stimulus exposure durations: 500 milliseconds (ms) and 2000 ms. The rationale for the inclusion of these times is outlined in the Introduction [see section 7.1] of this chapter. The 32 Angry-Neutral, 32 Happy-Neutral, and 16 Neutral-Neutral face pairs were presented once for each stimulus exposure duration. This resulted in a total of 160 trials (64 A-N; 64 H-N; 32 N-N). These trial numbers were chosen because it has been proposed that at least 16 trials are required for each trial type (Garner, 2010). Similar methodology and trial numbers have previously been utilised with primary school children (see Waters et al., 2010). Face pairs and presentation times were automatically selected at random. The inter-trial interval remained at 750 ms throughout the task since two stimulus exposure durations were included.

Two example trials and ten practice trials were also presented at the beginning of the task. Example trials involved the experimenter demonstrating the task to participants utilising pictures of two actors that were not included in the experimental/control trials. During the practice trials, the experimenter monitored participants' responses and provided feedback in order to ensure that participants understood the task. Reaction times (RTs) to probes and accuracy of responses were measured automatically by Inquisit experimental software.

7.2.8 Eye Tracking

Participants' eye movements were measured throughout the VP task with a Cambridge Research Systems (CRS) 50 Hz infrared eye tracker [see Figure 7.1]. This consisted of an 'EyeLock' headrest, which included a fully adjustable chinrest and head-strap. This made it easy to configure the eye tracker to participants of varying heights. Although fully adjustable, the 'EyeLock' headrest was rigid, which helped to prevent head movement throughout the experiment. An infrared mirror was utilised to reflect infrared light from two different sources to produce pupil and Purkinje¹ images on a dedicated infrared sensitive camera. This process was both safe and minimally invasive to participants since the mirror appeared transparent and the camera and illumination sources were out of view.

A program was developed in MATLAB to access the ET commands (i.e., 'calibrate', 'start/stop tracking', and 'save data') in the CRS Toolbox. This software was run on a separate computer to the VP task, in order to prevent reduced millisecond accuracy of Inquisit software, caused by sharing computer processor resources. A 'keyboard, visual display unit, and mouse' (KVM) switch was required to alternate between monitors so that calibration performed with the ET computer, and the VP task performed with the Inquisit computer could be presented on the same screen [see Figure 7.2]. Parallel port technology facilitated communication between the eye tracker, the ET computer and the Inquisit computer. Inquisit was programmed to send different signals to the ET computer indicating when: i) trials had begun; ii) central fixations had appeared; iii) face pairs were presented; and iv) visual probes had appeared. Different signals were also sent depending on the trial type (e.g., the signal 01100000 was utilised for Angry-Neutral Trials, whereas 11100000 was utilised for Happy-Neutral trials). The eye tracker itself transferred data to the ET computer, which was recorded by the Toolbox.

¹ Purkinje images are reflections of objects from the surface of the cornea, and from the anterior and posterior surfaces of the lens.

During the experiment, the height of the chin-rest and the head-strap were adjusted so that the participant was comfortable and their eye was level with the centre of the stimulus display. The stimulus monitor was always positioned centrally and perpendicularly to the eye tracker. The participant was then told to remain still and look straight ahead. The height and horizontal position of the camera had to be altered so that one of the participant's eyes appeared to be centred within the Toolbox's camera window. The camera was then focused so that the participant's pupil appeared defined in the video image [see Figure 7.3].

Once correctly positioned, the participant was required to undertake the calibration process. They were asked to remain still throughout. The calibration window [see Figure 7.4] displayed a target (i.e., a white dot) on the stimulus monitor and the participant was instructed to fixate on the target. Once the Toolbox had collected a consistent cluster of measurements, the target disappeared and a new target appeared in a different, random location. The participant was then instructed to fixate on this new target. This procedure was repeated until a sequence of 20 targets had been displayed. Once complete, the Toolbox was able to calculate all subsequent viewpoints directly from the image data.

After calibration, the participant was informed that they should remain still throughout the VP task but that they could have a break at any time. There was also a short break half-way in-between, where the participant was able to relax fully. Participants did not need to be re-calibrated since the rigidity of the 'EyeLock' headrest meant that they returned to the same position as before (Video Eye Tracker User Manual, 2008). Tracking of the eye movements began once the participant started the practice trials. Duration and location of fixations were recorded by the Toolbox and then this data was saved to MATLAB by the experimenter after the VP task.



Figure 7.1 The CRS 50 Hz infrared eye tracker.

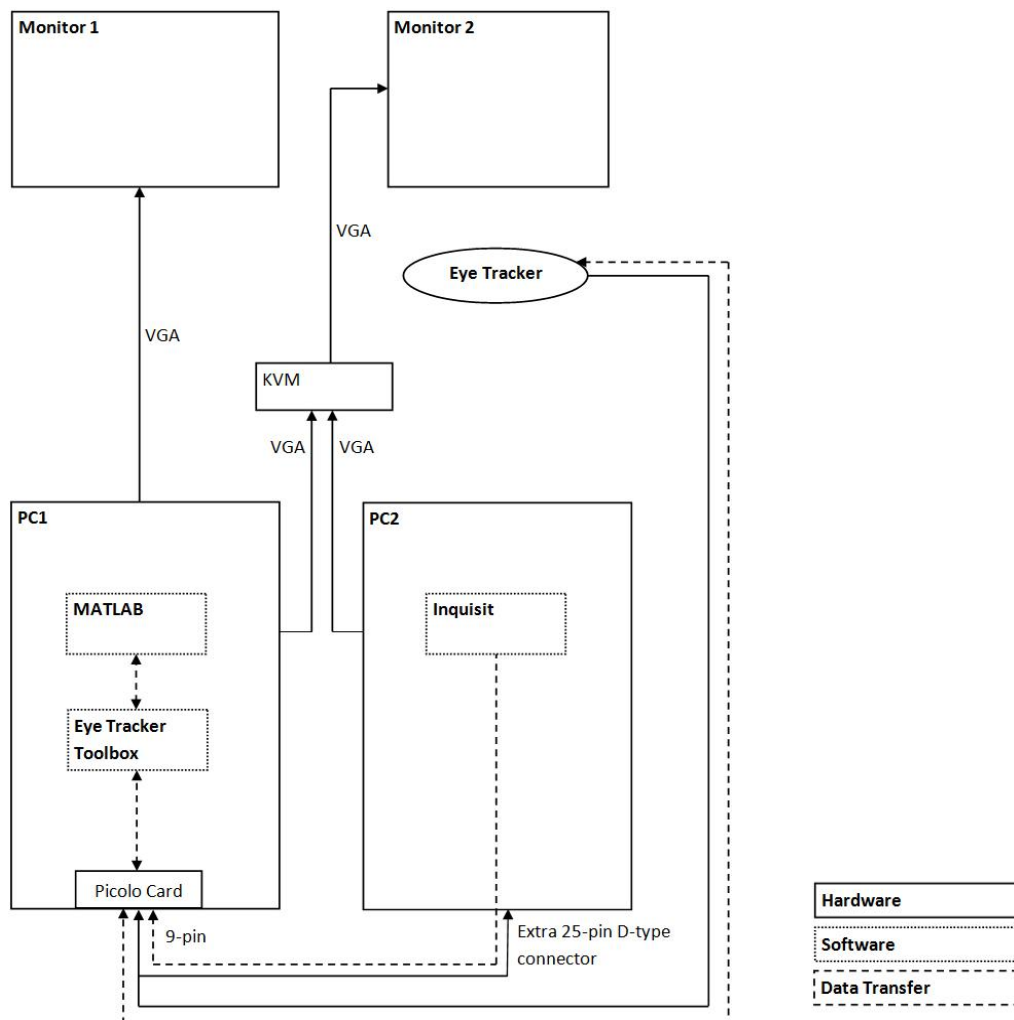


Figure 7.2 Diagram demonstrating communication between hardware and software during eye tracking.

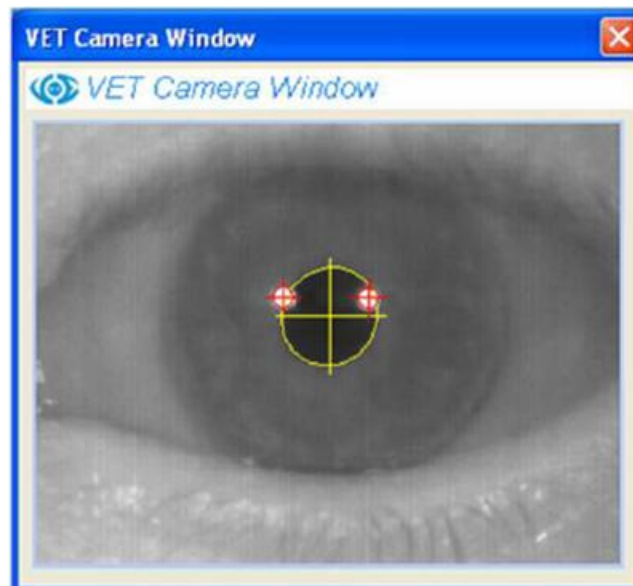


Figure 7.3 The eye tracker camera window displaying a centrally positioned eye (experimenter's view).

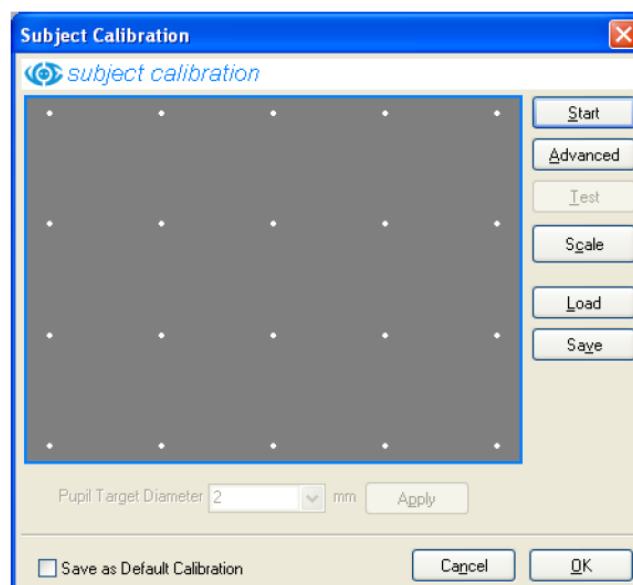


Figure 7.4 Calibration window with default settings (experimenter's view).

7.2.9 Subjective Appraisal Task

The final third of the current experiment involved asking participants to appraise their affective level for each face presented in the VP task. This process was the same as that described in the previous VP study [see Chapter 6, section 6.2.8]. That is, a separate visual analogue scale (VAS; Hayes & Patterson, 1921) was utilised to measure arousal and valence levels experienced by participants during the viewing of each face. In each VAS task, faces were presented in a random order. Each VAS task was presented in a separate block and consisted of 24 experimental trials (one for each face included in the VP paradigm). Two dummy trials were also included at the beginning of each VAS task, which contained actors who were not included in the VP paradigm. This resulted in a total of 52 trials.

7.2.10 Behavioural Data Preparation

The final participant sample consisted of 20 children (12 male; 8 female) aged between 8 and 11 years ($M = 9.70$; $SD = .86$). These were 10 high trait anxious (HTA) (4 male, 6 female; age range = 8-10 years, M age = 9.30, $SD = .67$; M trait = 45.80, $SD = 4.61$) and 10 low trait anxious (LTA) (8 male, 2 female; age range = 9-11 years, M age = 10.10, $SD = .88$; M trait = 25.80, $SD = 3.26$) children (M trait = 35.80, $SD = 10.97$). An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(18) = -11.20$, $p < .001$].

For the purpose of the state anxiety analysis, participants were assigned to groups of high and low levels of state anxiety based upon their responses in the STAIC-S (Spielberger, 1973). This resulted in 10 high state anxious (HSA) (5 male, 5 female; age range = 8-11 years, M age = 9.90, $SD = .99$; M state = 29.70, $SD = 3.20$) and 10 low state anxious (LSA) (7 male, 3 female; age range = 9-11 years, M age = 9.5, $SD = .71$; M state = 23.20, $SD = 2.44$) children (M state = 26.45, $SD = 4.33$). An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than the LSA group [$t(18) = -5.11$, $p < .001$].

Data were screened so that RTs from trials with incorrect responses were excluded (< 1% of trials), as were RTs that were less than 200 ms (0% of trials) or greater than three standard deviations above each participant's mean (< 1.5% of trials). This is a common procedure in VP study analysis (e.g., see Koster et al., 2005).

7.2.11 Behavioural Data Analysis

Data from the VP task were analysed as in the previous investigation [see Chapter 6, section 6.2.10]. For each of the conditions (i.e., 500 ms and 2000 ms), RTs to probes were utilised initially to examine overall effects of congruency, valence and anxiety level in both the state and trait anxiety analyses. Where significant congruency effects were observed, attentional bias scores for threatening and positive trials, and high anxious and low anxious groups were utilised in order to determine whether an attentional bias towards or away from stimuli took place. Specific components of attentional bias were then determined utilising the methods devised by Koster et al. (2004) and Legerstee et al. (2009) [see Chapter 6, section 6.1]. For the subjective appraisal task, data from 19 participants were analysed, as one child did not complete this final task due to fatigue.

7.2.12 Eye Tracking Data Preparation

During the experiment, two participants' eye movement data files could not be saved due to computer error. A further six participants were excluded from data analysis due to calibration issues. This resulted in a final participant sample of 12 (7 male; 5 female) children aged between eight and eleven years ($M = 9.67$; $SD = 0.98$). These were 5 HTA (1 male, 4 female; age range = 8-10 years, M age = 9, $SD = 0.71$; M trait score = 45.40, $SD = 5.22$) and 7 LTA (6 male, 1 female; age range = 9-11 years, M age = 10.14, $SD = 0.90$; M trait score = 26.14, $SD = 3.89$) participants. An independent measures t-test demonstrated that the HTA group had significantly higher trait anxiety scores than the LTA group [$t(10) = -7.35$, $p < .001$].

For the purpose of the state anxiety analysis, participants were assigned to groups of high and low levels of state anxiety based upon their responses in the STAIC-S (Spielberger, 1973). This resulted in 7 HSA (4 male, 3 female; age range = 8-11 years, M age = 9.71, $SD = 1.11$; M state score = 30.29, $SD = 3.64$) and 5 LSA (3 male, 2 female; age range = 9-11 years, M age = 9.60, $SD = 0.89$; M state score = 24.00, $SD = 2.55$) children. An independent measures t-test demonstrated that the HSA group had significantly higher state anxiety scores than the LSA group [$t(10) = -3.31$, $p = .008$].

Eye fixations were classed as valid and included in the analysis if they: i) lasted at least 200 ms long; and ii) occurred after the first 200 ms of each trial. This is because although the duration of a fixation is said to be at least 150 ms long (Irwin, 1992), overt attention is thought to occur at approximately 200 ms (Stevens, Rist, & Gerlach, 2011). Trials

were removed where the fixation location at the beginning of the trial was more than one degree away from the central fixation region. Blinks were identified where no pupil diameter measurements were reported within a trial and this data was excluded. This resulted in approximately 120 usable trials per participant. This methodology is similar to previous ET studies (e.g., Gamble & Rapee, 2009).

7.2.13 Eye Tracking Data Analysis

Biases in **initial orienting** were investigated for each participant and face type utilising the location of the first fixation made to stimuli presented in either the 500 ms or 2000 ms condition. Both trial types were included since the first fixation did not necessarily occur within the first 500 ms. This method of analysis has been applied in previous adult and child eye movement studies (Bradley, Mogg, & Millar, 2000; Gamble & Rapee, 2009; Garner et al., 2006). Initial orienting bias scores were calculated as a function of the number of trials in which the first fixation was directed towards the emotive face as a proportion of the total number of trials that included valid eye movements. That is, *the number of trials in which the first fixation was directed towards the emotive face divided by the total number of trials in which first fixations were directed to emotive-neutral face pairs per se*. These bias scores are said to represent the relative frequency of initially orienting towards the emotive face as opposed to the neutral face, with scores greater than 0.5 indicating engagement to the emotive face and scores smaller than 0.5 reflecting avoidance of the emotive face (Gamble & Rapee, 2009).

Biases in **sustained attention** (i.e., the time course of attentional allocation) were also investigated by analysing eye movements made to stimuli throughout the entire 2000 ms exposure duration. Similarly to previous studies (Gamble & Rapee, 2009; In-Albon et al., 2010; Rohner, 2002), the 2000 ms presentation time was divided into four 500 ms intervals (0-500 ms; 501-1000 ms; 1001-1500 ms; 1501-2000 ms) and the amount of time fixated on the emotive face was computed for each face type and time interval. Maintenance bias scores were calculated as a function of *the amount of time fixated on an emotive face divided by the total amount of time fixated on the emotive-neutral face pair per se* for each particular time bin. Here again, scores greater than 0.5 indicate an attentional bias towards the emotive face whilst scores smaller than 0.5 reflect an attentional bias away from the emotive face. This methodology is similar to that of Schechner et al. (2013).

7.3 Results

7.3.1 500 ms Visual Probe Results

7.3.1.1 Trait Anxiety Analysis

7.3.1.1.1 Reaction Time Data

Table 7.1 shows the mean RTs to probes during each trial type for both HTA and LTA participants.

Table 7.1

Mean Reaction Times to Probes (with Standard Deviations in Parentheses) as a Function of Trait Anxiety, Valence and Congruency

	Angry		Happy		Total
	Congruent	Incongruent	Congruent	Incongruent	
High Trait Anxiety	577.14(66.49)	583.04 (78.26)	568.76 (66.41)	568.28 (89.40)	571.56 (72.22)
Low Trait Anxiety	515.92 (94.88)	523.33 (88.94)	550.79 (86.23)	536.18 (77.40)	532.86 (83.30)
Total	546.53 (80.69)	553.19 (83.60)	559.78 (76.23)	552.23 (83.40)	
	549.86 (82.15)		556.01 (79.82)		

To examine congruency effects, as suggested by Koster et al. (2004), RTs were subjected to a 2 X 2 X 2 mixed analysis of variance (ANOVA) with Trait Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for trait anxiety [$F(1, 18) = 1.57, p = .226; \eta_p^2 = .08$], valence [$F(1, 18) = 1.04, p = .321; \eta_p^2 = .06$], or congruency [$F(1, 18) = .00, p = .963; \eta_p^2 = .00$]. There was a significant interaction between trait anxiety and valence [$F(1, 18) = 8.66, p = .009; \eta_p^2 = .33$], however, interaction effects between trait anxiety and congruency [$F(1, 18) = .11, p = .740; \eta_p^2 = .01$], valence and congruency [$F(1, 18) = 1.10, p = .309; \eta_p^2 = .06$], and trait anxiety,

valence, and congruency [$F(1, 18) = .33, p = .571; \eta_p^2 = .02$] did not reach statistical significance. Given that there were no effects of congruency, no further analyses were conducted (see Koster et al., 2004).

7.3.1.2 State Anxiety Analysis

7.3.1.2.1 Reaction Time Data

To examine congruency effects, RTs were subjected to a 2 X 2 X 2 mixed ANOVA with State Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for state anxiety [$F(1,18) = 1.24, p = .280; \eta_p^2 = .07$], valence [$F(1,18) = .78, p = .390; \eta_p^2 = .04$] or congruency [$F(1,18) = .00, p = .963; \eta_p^2 = .00$]. Furthermore, the interaction effects between state anxiety and valence [$F(1,18) = 1.83, p = .193; \eta_p^2 = .09$], state anxiety and congruency [$F(1,18) = .45, p = .509; \eta_p^2 = .03$], valence and congruency [$F(1,18) = 1.26, p = .277; \eta_p^2 = .07$], and trait anxiety valence, and congruency [$F(1,18) = 2.96, p = .102; \eta_p^2 = .14$] did not reach statistical significance. Given that there were no effects of congruency, no further analyses were conducted (see Koster et al., 2004).

7.3.2 2000 ms Visual Probe Results

7.3.2.1 Trait Anxiety Analysis

7.3.2.1.1 Reaction Time Data

Table 7.2 shows the mean RTs to probes during each trial type for both HTA and LTA participants.

To examine congruency effects, RTs were subjected to a 2 X 2 X 2 mixed ANOVA with Trait Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for trait anxiety [$F(1, 18) = 1.53, p = .232; \eta_p^2 = .08$], valence [$F(1, 18) = .57, p = .462; \eta_p^2 = .03$] or congruency [$F(1, 18) = .54, p = .472; \eta_p^2 = .03$]. The interaction effects between trait anxiety and valence [$F(1, 18) = .42, p = .523; \eta_p^2 = .02$], and valence and congruency [$F(1, 18) = 1.47, p = .241; \eta_p^2 = .08$] did not reach

statistical significance. However, there was a trend towards a significant interaction between trait anxiety and congruency [$F(1, 18) = 4.01, p = .061; \eta_p^2 = .18$], and a significant interaction between trait anxiety, valence and congruency [$F(1, 18) = 4.70, p = .044; \eta_p^2 = .21$].

Table 7.2 *Mean Reaction Times to Probes (with Standard Deviations in Parentheses) as a Function of Trait Anxiety, Valence and Congruency*

	Angry		Happy		Total
	Congruent	Incongruent	Congruent	Incongruent	
High Trait Anxiety	579.93 (75.28)	549.92 (61.05)	550.92 (76.08)	566.29 (80.62)	559.26 (69.57)
Low Trait Anxiety	512.00 (87.51)	534.21 (48.18)	517.07 (71.05)	527.34 (82.33)	522.05 (72.79)
Total	545.97 (81.40)	542.07 (54.62)	533.00 (73.67)	546.82 (81.48)	
	544.02 (68.01)		539.91 (77.57)		

7.3.2.1.2 Attentional Bias Scores

In order to clarify the interaction effects, attentional bias scores were calculated for each trial type and participant utilising the formula proposed by MacLeod and Mathews (1988) [see Chapter 6, section 6.2.10]. Mean attentional bias scores for angry and happy faces for the high and low trait anxious groups are presented in Table 7.3.

Table 7.3

Mean Attentional Bias Scores (with Standard Deviations in Parentheses) as a Function of Trait Anxiety and Valence

Valence	High Trait Anxiety	Low Trait Anxiety	Total
Angry	-30.00 (47.32)	22.20 (47.91)	-3.90 (47.62)
Happy	15.37 (63.60)	9.37 (30.25)	12.37 (46.93)
Total	-7.32 (55.46)	15.79 (39.08)	

Attentional bias scores were subjected to a 2 X 2 mixed ANOVA with Trait Anxiety (high versus low) as the between-groups variable and Valence (angry versus happy) as the within-groups variable. Results revealed a trend towards significance for the main effect of trait anxiety [$F(1, 18) = 4.01, p = .061; \eta_p^2 = 0.18$] but no main effect for valence [$F(1, 18) = 1.47, p = 0.241; \eta_p^2 = 0.08$]. There was a significant interaction between trait anxiety and valence [$F(1, 18) = 4.70, p = 0.04; \eta_p^2 = 0.21$] [see Figure 7.5].

To clarify the interaction, two independent t-tests of attentional bias scores, with Trait Anxiety (high versus low) as the independent variable, were undertaken for threatening and positive trials separately. For threatening trials, results showed that there was a significant difference in HTA and LTA participants' performance [$t(18) = 2.45, p = .025, d = 1.10$], such that HTA participants demonstrated an attentional bias away from angry faces ($M = -30.00, SD = 47.32$), whereas LTA participants demonstrated an attentional bias towards angry faces ($M = 22.20, SD = 47.91$). To investigate this finding further, difference from zero was also assessed (see Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). That is, one-sample t-tests were conducted for both HTA and LTA children by comparing their mean attentional bias scores to "0", (the theoretical *non*-bias score reference point). An attentional bias score of "0" represents equal reaction times to invalid and valid trials, thereby indicating *no* bias toward or away from either stimulus type. It was found that the attentional bias score for angry faces trended towards differing significantly from zero in the HTA group [$t(9) = -2.00, p = .076, d = .63$] but not the LTA group [$t(9) = 1.47, p = .177, d = .46$].

For positive trials, there was no significant difference in HTA and LTA participants' performance [$t(18) = -.46, p = .654, d = .13$].

To investigate these effects further, two repeated measures t-tests of attentional bias scores, with Trial Type (threatening versus positive) as the independent variable, were also undertaken for HTA and LTA participants separately. For HTA participants, results revealed that there was a significant difference in attentional bias scores for angry versus happy faces [$t(9) = -2.47, p = .035, d = .82$], with participants displaying an attentional bias away from angry faces ($M = -30.00, SD = 47.32$) and an attentional bias towards happy faces ($M = 15.37, SD = 63.60$). In addition and as reported above, HTA participants' negative attentional bias score for angry faces trended towards differing significantly from zero. However, their positive attentional bias score for happy faces did not [$t(9) = 1.70, p = .123, d = .24$].

For LTA participants, there was no significant difference in attentional bias scores for angry versus happy faces [$t(9) = -.65, p = .529, d = .33$].

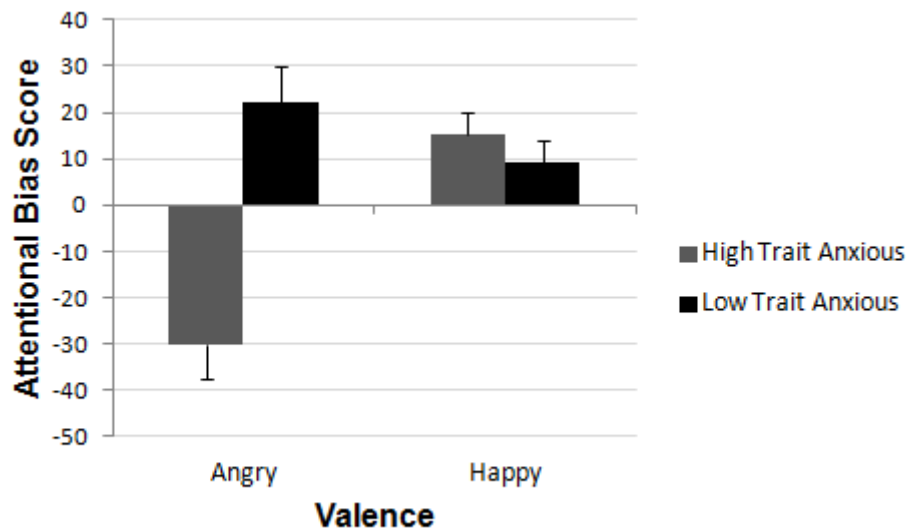


Figure 7.5 Attentional bias scores as a function of trait anxiety and valence. Error bars represent standard errors of the mean.

7.3.2.1.3 Components of Attentional Bias

The previous analyses revealed a negative attentional bias score for angry faces in HTA participants. In order to determine whether this effect was due to avoidance of *or* a tendency not to engage attention with angry faces, congruent and incongruent threatening trials were compared with neutral-neutral baseline trials in HTA participants, respectively. For these two analyses, repeated measures t-tests of reaction times were conducted separately for each congruency.

For congruent threatening trials, results revealed that there was a trend towards a significant difference in how HTA participants responded [$t(9) = 2.05, p = .071, d = 0.42$], such that RTs were slower for probes that replaced angry faces ($M = 579.93, SD = 75.28, SE = 23.80$) compared with neutral faces ($M = 549.24, SD = 72.45, SE = 22.91$).

For incongruent threatening trials, there was no significant difference in how HTA participants responded to angry faces ($M = 549.92, SD = 61.05, SE = 19.31$) compared with neutral faces [$t(9) = .06, p = .950, d = 0.01$]. These results suggest that HTA participants displayed a tendency not to engage attention with angry faces. This will be considered further in the Discussion of this chapter [see section 7.4].

7.3.2.2 State Anxiety Analysis

7.3.2.2.1 Reaction Time Data

To examine congruency effects, RTs were subjected to a 2 X 2 X 2 mixed ANOVA with State Anxiety (high versus low) as the between-groups variable, and Valence (angry versus happy) and Congruency (congruent versus incongruent) as the within-groups variables. Results revealed no main effects for state anxiety [$F(1, 18) = 2.10, p = .164; \eta_p^2 = .11$], valence [$F(1, 18) = .57, p = .462; \eta_p^2 = .03$] or congruency [$F(1, 18) = .44, p = .515; \eta_p^2 = .02$]. Furthermore, the interaction effects between state anxiety and valence [$F(1,18) = .41, p = .533; \eta_p^2 = .02$], state anxiety and congruency [$F(1, 18) = .02, p = .891; \eta_p^2 = .00$], valence and congruency [$F(1, 18) = 1.24, p = .280; \eta_p^2 = .06$], and state anxiety, valence and congruency [$F(1, 18) = 1.15, p = .297; \eta_p^2 = .06$] did not reach statistical significance. Given that there was no effect of congruency, no further analyses were conducted (see Koster et al., 2004).

7.3.2.3 Attentional Control and Trait Anxiety

Table 7.4 shows the number of participants that were either high or low in levels of trait anxiety and either low or high in levels of AC.

Table 7.4

Frequency of Participants as a Function of Trait Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)

	High Trait Anxiety	Low Trait Anxiety	Total
High Attentional Control	3	9	12
Low Attentional Control	7	1	8
Total	10	10	

The Fisher's exact probability test was conducted since 50% of the cells had an expected frequency of less than 5. This revealed that there was a significant association between trait anxiety level and AC level [$p = .020, N = 10$]. That is, HTA was associated with low AC, and LTA was associated with high AC. Cramer's V was found to be 0.61, thus approximately 37% of the variation in frequencies of anxiety can be explained by AC.

Since results suggested a bias away from (i.e., a tendency not to engage with) angry faces in HTA participants, there was no rationale to conduct further analyses. This is because AC is thought to be associated with *impaired disengagement* from threat (Cisler & Koster, 2010).

7.3.2.4 Attentional Control and State Anxiety

Table 7.5 shows the number of participants that were either high or low in levels of state anxiety and either low or high in levels of AC.

Table 7.5

Frequency of Participants as a Function of State Anxiety Level (High versus Low) and Attentional Control Level (High versus Low)

	High State Anxiety	Low State Anxiety	Total
High Attentional Control	6	6	12
Low Attentional Control	4	4	8
Total	10	10	

The Fisher's exact probability test was conducted since 50% of the cells had an expected frequency of less than 5. This revealed that there was no significant association between anxiety level and AC level [$p = 1.00$, $N = 10$]. The value of Cramer's V was 0.00, showing that the relationship between anxiety and AC was zero.

Given that AC is thought to be associated with attentional bias for *threat* (Eysenck et al., 2007) and in particular, *impaired disengagement* of threat (Cisler & Koster, 2010), no further analyses were undertaken.

7.3.2.5 Subjective Appraisal and Trait Anxiety

7.3.2.5.1 Arousal Analysis

To investigate the effects of trait anxiety and face type on arousal ratings, a mixed ANOVA was carried out with Trait Anxiety (high [$N = 10$] versus low [$N = 9$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was arousal ratings, where 0% =

‘very nervous’ and 100% = ‘very relaxed’. Results revealed that there was a main effect for face type [$F(2, 34) = 213.51, p < .001, \eta_p^2 = .93$] but not for trait anxiety [$F(1, 17) = .48, p = .497, \eta_p^2 = .03$]. The interaction effect between trait anxiety and face type did not reach statistical significance either [$F(2, 34) = 1.08, p = .353, \eta_p^2 = .06$].

For the main effect of face type, pair-wise Bonferroni corrected comparisons revealed lower ratings for angry faces ($M = 16\%, SD = 7\%$) compared with neutral faces ($M = 48\%, SD = 12\%; p < .001, d = 3.37$), and happy faces ($M = 76\%, SD = 14\%; p < .001, d = 5.71$). Findings further revealed lower ratings for neutral faces compared with happy faces ($p < .001, d = 2.15$) [see Figure 7.6].

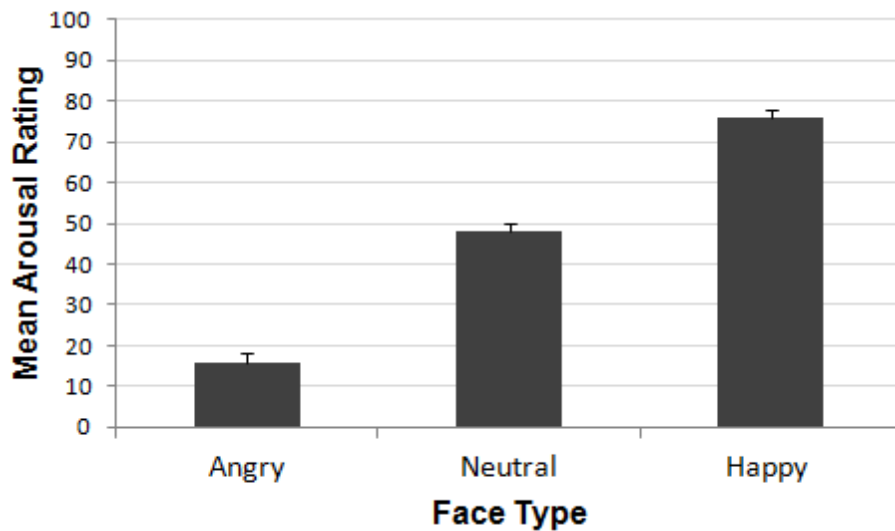


Figure 7.6 The effect of face type on mean subjective arousal ratings. Error bars represent standard errors of the mean.

7.3.2.5.2 Valence Analysis

To investigate the effects of trait anxiety and face type on valence ratings, a mixed ANOVA was carried out with Trait Anxiety (high [$N = 10$] versus low [$N = 9$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was valence ratings, where 0% = ‘very unpleasant’ and 100% = ‘very pleasant’. Results revealed that there was a main effect for face type [$F(2, 34) = 306.08, p < .001, \eta_p^2 = .95$] but not for trait anxiety [$F(1, 17) = .02, p = .901, \eta_p^2 = .00$]. The interaction effect between trait anxiety and face type did not reach statistical significance either [$F(2, 34) = .04, p = .965, \eta_p^2 = .00$].

For the main effect of face type, pair-wise Bonferroni corrected comparisons revealed lower ratings for angry faces ($M = 12\%$, $SD = 6\%$) compared with neutral faces ($M = 42\%$, $SD = 9\%$; $p < .001$, $d = 4.00$), and happy faces ($M = 79\%$, $SD = 10\%$; $p < .001$, $d = 8.38$). Findings further revealed lower ratings for neutral faces compared with happy faces ($p < .001$, $d = 3.89$) [see Figure 7.7].

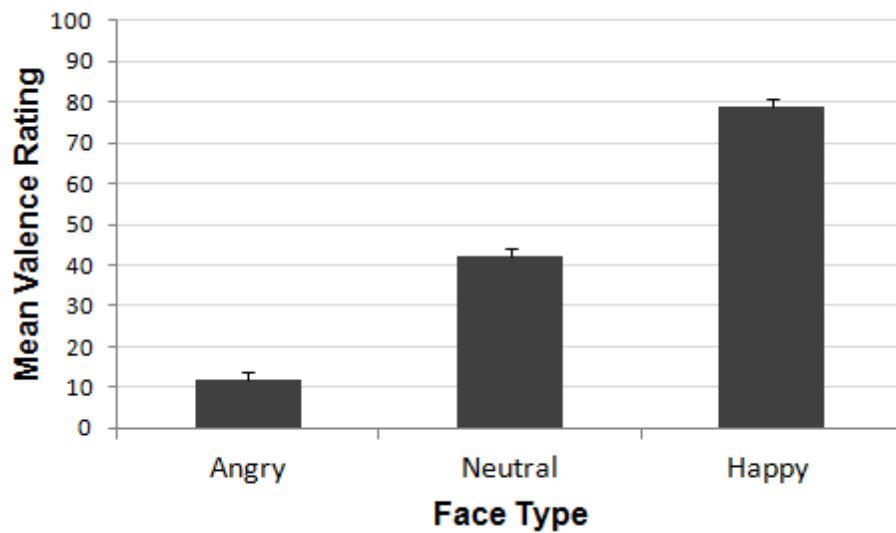


Figure 7.7 The effect of face type on mean subjective valence ratings for each face type.

Error bars represent standard errors of the mean.

7.3.2.6 Subjective Appraisal and State Anxiety

7.3.2.6.1 Arousal Analysis

To investigate the effects of state anxiety and face type on arousal ratings, a mixed ANOVA was carried out with State Anxiety (high [$N = 10$] versus low [$N = 9$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was arousal ratings, where 0% = ‘very nervous’ and 100% = ‘very relaxed’. Results revealed that there was a main effect for face type [$F(2, 34) = 206.80$, $p < .001$, $\eta_p^2 = .92$] but not for state anxiety [$F(1, 17) = 1.31$, $p = .268$, $\eta_p^2 = .07$]. The interaction effect between state anxiety and face type did not reach statistical significance [$F(2, 34) = 0.62$, $p = .544$, $\eta_p^2 = .04$].

7.3.2.6.2 Valence Analysis

To investigate the effects of state anxiety and face type on valence ratings, a mixed ANOVA was carried out with State Anxiety (high [$N = 10$] versus low [$N = 9$]) as the independent between-groups variable and Face Type (angry, happy, neutral) as the independent within-groups variable. The dependent variable was valence ratings, where 0% = ‘very unpleasant’ and 100% = ‘very pleasant’. Results revealed that there was a main effect for face type [$F(2, 34) = 344.94, p < .001, \eta_p^2 = .95$] but not for state anxiety [$F(1, 17) = .10, p = .757, \eta_p^2 = .01$]. The interaction effect between state anxiety and valence did not reach statistical significance [$F(2, 34) = 2.38, p = .108, \eta_p^2 = .12$].

7.3.3 Eye Tracking Results

7.3.3.1 Trait Anxiety Analysis

7.3.3.1.1 Biases in Initial Orienting to Stimuli Presented for 500 ms

Attentional bias scores were entered into a 2 X 2 mixed ANOVA with Trait Anxiety (high versus low) as the between subjects variable and Valence (angry versus happy) as the within subjects variable. Results revealed a significant main effect for valence [$F(1, 10) = 5.18, p = .046; \eta_p^2 = .34$]. However, there was no main effect for anxiety [$F(1, 10) = 1.09, p = 0.322; \eta_p^2 = .10$] and no significant interaction between trait anxiety and valence [$F(1, 10) = 1.86, p = .203; \eta_p^2 = .16$].

For the main effect of valence, bias scores indicate that participants avoided happy faces ($M = .21, SD = .11$) to a greater extent than angry faces ($M = .26, SD = .14; p = .046, d = .40$).

7.3.3.1.2 Biases in Initial Orienting to Stimuli Presented for 2000 ms

Attentional bias scores were entered into a 2 X 2 mixed ANOVA with Trait Anxiety (high versus low) as the between subjects variable and Valence (angry versus happy) as the within subjects variable. Results revealed a significant main effect for valence [$F(1, 10) = 53.35, p < .001; \eta_p^2 = .84$]. However, there was no main effect for anxiety [$F(1, 10) = .95, p = .353; \eta_p^2 = .09$] and no significant interaction between trait anxiety and valence [$F(1, 10) = .00, p = .988; \eta_p^2 = .00$].

For the main effect of valence, bias scores indicate that participants displayed facilitated engagement towards angry faces ($M = .62$, $SD = .09$) but not happy faces ($M = .49$, $SD = .08$; $p < .001$, $d = 1.53$).

7.3.3.1.3 Biases in Sustained Attention of Stimuli Presented for 2000 ms

Attentional bias scores were subjected to a 2 X 2 X 4 mixed ANOVA with Trait Anxiety (high versus low) as the between subjects variable, and Valence (angry versus happy) and Time Interval (0-500 ms; 500-1000 ms; 1000-1500 ms; 1500-2000 ms) as the within subjects variables. Mauchly's test indicated that the assumption of sphericity had been violated for time interval [$\chi^2(5) = 13.15$, $p = .023$], therefore degrees of freedom were corrected utilising Greenhouse-Geisser estimates of sphericity ($\epsilon = .59$). Results revealed a significant main effect for valence [$F(1, 10) = 64.85$, $p < .001$, $\eta_p^2 = .87$]. However, there were no main effects for trait anxiety [$F(1, 10) = .20$, $p = .891$, $\eta_p^2 = .00$] or time interval [$F(1.76, 17.56) = .79$, $p = .454$, $\eta_p^2 = .07$]. Furthermore, the interaction effects between trait anxiety and valence [$F(1, 10) = 1.69$, $p = .223$, $\eta_p^2 = .14$], trait anxiety and time interval [$F(1.76, 17.56) = 1.39$, $p = .272$, $\eta_p^2 = .12$], valence and time interval [$F(1.41, 14.06) = .12$, $p = .814$, $\eta_p^2 = .01$], and trait anxiety, valence and time interval [$F(1.41, 14.06) = .33$, $p = .652$, $\eta_p^2 = .03$] did not reach statistical significance.

For the main effect of valence, bias scores indicate that participants displayed facilitated engagement towards angry faces ($M = .65$, $SD = .21$) but not happy faces ($M = .52$, $SD = .08$; $p < .001$, $d = .87$).

7.3.3.2 State Anxiety Analysis

7.3.3.2.1 Biases in Initial Orienting to Stimuli Presented for 500 ms

Table 7.6 shows the mean attentional bias scores for each face type and trait anxiety group. Attentional bias scores were subjected to a 2 X 2 mixed ANOVA with State Anxiety (high versus low) as the between subjects variable and Valence (angry versus happy) as the within subjects variable. Results revealed a trend towards significance for the main effect of state anxiety [$F(1, 10) = 3.81$, $p = .080$; $\eta_p^2 = .28$]. There was also a trend towards significance for the main effect of valence [$F(1, 10) = 4.42$, $p = .062$; $\eta_p^2 = .31$]. However, there was no significant interaction between state anxiety and valence [$F(1, 10) = .80$, $p = .393$; $\eta_p^2 = .07$].

For the main effect of state anxiety, bias scores indicate that HSA participants ($M = .19$, $SD = .11$) avoided angry and happy face pairs to a greater extent than did LSA participants ($M = .31$, $SD = .13$; $p = .080$, $d = 1.00$). For the main effect of valence bias scores indicate that participants avoided happy faces ($M = .22$, $SD = .11$) to a greater extent than angry faces ($M = .27$, $SD = .14$; $p = .062$, $d = 1.52$).

Table 7.6

Mean Attentional Bias Scores (with Standard Deviations in Parentheses) as a Function of State Anxiety and Valence for the 500 ms Condition

Valence	High State Anxiety	Low State Anxiety	Total
Angry	.20 (.12)	.34 (.14)	.27 (.14)
Happy	.17 (.09)	.27 (.11)	.22 (.11)
Total	.19 (.11)	.31 (.13)	

7.3.3.2.2 Biases in Initial Orienting to Stimuli Presented for 2000 ms

Attentional bias scores were subjected to a 2 X 2 mixed ANOVA with State Anxiety (high versus low) as the between subjects variable and Valence (angry versus happy) as the within subjects variable. Results revealed a significant main effect for valence [$F(1, 10) = 70.66$, $p < .001$; $\eta_p^2 = 0.88$], such that participants displayed facilitated engagement towards angry faces ($M = 0.62$, $SD = 0.09$) compared with happy faces ($M = 0.48$, $SD = 0.08$; $p < .001$, $d = 1.65$). However, there was no main effect for anxiety [$F(1, 10) = 0.12$, $p = 0.735$; $\eta_p^2 = 0.01$] and no significant interaction between trait anxiety and valence [$F(1, 10) = 2.43$, $p = 0.150$; $\eta_p^2 = 0.20$].

For the main effect of valence, bias scores indicate that participants displayed facilitated engagement towards angry faces ($M = 0.62$, $SD = 0.09$) compared with happy faces ($M = 0.48$, $SD = 0.08$; $p < .001$, $d = 1.65$).

7.3.3.2.3 Biases in Sustained Attention of Stimuli Presented for 2000 ms

Attentional bias scores were subjected to a 2 X 2 X 4 mixed ANOVA with State Anxiety (high versus low) as the between subjects variable, and Valence (angry versus happy) and Time Interval (0-500 ms; 501-1000 ms; 1001-1500 ms; 1501-2000 ms) as the within subjects variables. Mauchly's test indicated that the assumption of sphericity had been

violated for time interval [$\chi^2(5) = 17.79, p = .003$], therefore degrees of freedom were corrected utilising Greenhouse-Geisser estimates of sphericity ($\epsilon = .57$). Results revealed a significant main effect for valence [$F(1, 10) = 78.16, p < .001, \eta_p^2 = .89$]. However, there were no main effects for state anxiety [$F(1, 10) = .62, p = .451, \eta_p^2 = .06$] or time interval [$F(1.70, 17.00) = .84, p = .430, \eta_p^2 = .08$]. Furthermore, the interaction effects between state anxiety and valence [$F(1, 10) = 2.56, p = .140, \eta_p^2 = .20$], state anxiety and time interval [$F(1.70, 17.00) = .86, p = .425, \eta_p^2 = .08$], valence and time interval [$F(1.49, 14.85) = .10, p = .855, \eta_p^2 = .01$], and trait anxiety, valence and time interval [$F(1.49, 14.85) = .24, p = .726, \eta_p^2 = .02$] did not reach statistical significance.

For the main effect of valence, bias scores indicate that participants displayed facilitated engagement towards angry faces ($M = .66, SD = .11$) compared with happy faces ($M = .52, SD = .07; p < .001, d = 1.56$).

7.4 Discussion

The aim of the present investigation was to investigate the time course of visual attention for emotive stimuli in high anxious versus low anxious eight to eleven year old children utilising the VP paradigm and ET technology. Findings relating to the behavioural data did not reveal any effects of anxiety or any differences in attentional bias for angry or happy faces during intermediate overt attentional processes (500 ms). However, it was found that HTA, relative to LTA, children biased their attention away from angry faces during later overt attentional processes (2000 ms). It was further found that HTA children biased their attention away from angry faces compared with happy faces. In relation to this finding, it was demonstrated that the attentional bias consisted of a tendency not to engage with threat rather than avoiding the angry faces by allocating attention to other spatial locations (in this case, the neutral faces). In addition, whilst subjective appraisal data demonstrated that there were no differences between high and low anxious participants on the VAS tasks, it was found that children gave the lowest ratings for angry faces and the highest ratings for happy faces on both the arousal and valence scales. A final finding for the behavioural data was that HTA children typically possessed high levels of AC, whereas LTA children typically possessed low levels of AC.

In regards to the ET data, findings demonstrated that irrespective of anxiety level, participants displayed greater initial avoidance of happy faces than angry faces in the 500 ms

condition. It was also found that there was a trend for HSA children to avoid both angry and happy faces to a greater extent than the LSA children. For the 2000 ms condition, results further revealed that all participants initially attended towards angry faces compared with happy faces. Analysis of sustained attention revealed that this pattern of orienting towards threat continued throughout the 2000 ms exposure. These results will now be discussed in turn.

7.4.1 Behavioural Data

The finding that anxiety did not influence attentional allocation for stimuli presented for 500 ms was unexpected [*see hypothesis i), section 7.1*] as it does not agree with previous child research. Here, findings have been equivocal in that some studies have demonstrated an attentional bias towards threatening faces (Brotman et al., 2007; Heim-Dreger et al., 2006; Monk et al., 2006; Roy et al., 2008; Telzer et al., 2008; Waters et al., 2010), whilst others have demonstrated an attentional bias away from such stimuli (Monk et al., 2008; Pine et al., 2005; Stirling et al., 2006) in anxious children. The fact that the present study found no differences between HTA and LTA is interesting in light of these findings and could be due to this past research often focusing on clinical anxiety and typically including different age ranges. That said, this needs to be investigated further as there is currently no definitive explanation to account for these varied findings.

Of importance was the finding that eight to eleven year old children who experience high levels of trait anxiety display a later bias of spatial attention away from angry faces. As well as supporting hypothesis ii) [*see section 7.1*], this result accords with previous adult VP studies that have demonstrated an attentional bias away from threatening for longer exposure durations (Koster et al., 2005; Mogg, Bradley, Miles, & Dixon, 2004). It also offers support for the second stage of Mogg and Bradley's (1998) 'cognitive-motivational model' and similar theories (Mogg & Bradley, 1998; Mogg et al., 1997; Mogg et al., 1987), which argue that detailed processing of threat information is avoided in an attempt to reduce subjective anxiety.

Cognitive models of child anxiety suggest that this tendency to avoid threatening information is related to both the development and maintenance of anxiety disorder (Hudson & Rapee, 2004; Rapee, 2001). According to these models, avoidance of threat prevents anxious individuals from being able to challenge negative beliefs and reappraise accordingly. In contrast, attending to threatening stimuli allows exposure to the stimulus and aids recovery

by providing the opportunity for anxious individuals to make more rational appraisals. Thus, the current study may have important implications concerning the assessment and treatment of anxious children. Indeed, it is also important to note that the present investigation extends previous studies of the time course of attentional allocation (Bradley et al., 1998; Garner et al., 2006; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2005; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg et al., 2004) by attempting to disentangle the specific components of attentional bias. It appears that this is the first study of the time course of attentional bias to demonstrate ‘tendency not to engage with’ threat in high anxious children, rather than to simply assume/infer that results reflect avoidance (i.e., allocating attention towards other spatial locations).

The subjective appraisal data does not support hypothesis v) since it demonstrated that ratings for both arousal and valence were lowest for angry faces and highest for happy faces, irrespective of anxiety level. This suggests that angry faces made all children feel the most nervous and that children felt that these faces were the most unpleasant stimulus too. In contrast, happy faces made children feel the least nervous and were rated as the most pleasant stimulus. These findings accord with the previous VP study [*see Chapter 6*] and offer further validity for the NimStim faces utilised in this thesis. These stimuli were originally chosen because of their high reliability and validity ratings, as determined by Tottenham et al. (2009) [*see Chapter 6, section 6.2.3 and Table 6.2*].

Findings relating to AC showed that HTA children typically experienced lower levels of AC, whilst LTA children typically experienced higher levels of AC. This is consistent with Eysenck et al.’s (2007) assumption that higher levels of anxiety decrease the two functions of executive control associated with AC: attentional inhibition / focusing and shifting. Thus, it may be the case that higher levels of anxiety: i) reduce the degree to which inhibitory mechanisms are able to regulate automatic responses; and ii) increase the degree to which attention is shifted from one task to another. According to Cisler and Koster (2010), these effects may manifest in either the impaired disengagement of attention from distracting threat stimuli or in the facilitated engagement of attention towards threat, respectively. Thus, it is important for future research to include measures of AC to both replicate the present finding and to test whether AC is associated with these components of attentional bias in children (should they emerge).

7.4.1 Eye Tracking Data

The finding that all children directed their first fixation away from happy faces in the 500 ms condition does not support hypothesis iii), which stated that high anxious children would display an initial attentional bias towards angry faces (i.e., hypothesis iii). Furthermore, it does not agree with the majority of previous adult ET studies in the area, which have demonstrated either facilitated engagement (Horley et al., 2004; Mogg et al., 2000; Richards et al., unpublished, as cited in Donnelly et al., 2010), avoidance (Rohner, 2002) or both facilitated engagement and avoidance (Rinck & Becker, 2006; Pflugshaupt et al., 2005) for *threatening* stimuli in *anxiety*. Although not specific to anxious participants, the current finding of greater initial avoidance of happy faces compared with angry faces is similar to that of a recent child study conducted by Gamble and Rapee (2009). Here, it was found that clinically anxious, relative to non-anxious, seven to eleven year olds initially oriented attention away from happy faces. A similar finding was also demonstrated in study five of the current thesis [see Chapter 6], where HTA children, in comparison to LTA children, biased their covert attention away from happy faces presented for 200 ms.

As stated in Chapter 6 [see section 6.4], an attentional bias away from happy faces may be due to individuals interpreting these faces as signifying social approach (Bradley et al., 1999; Campbell et al., 2009; Heuer, Rinck, & Becker, 2007; Rapee & Heimberg, 1997) or social dominance (Hess, Adams, & Kleck, 2005; Hess, Blairy, & Kleck, 2000; Heuer et al., 2007; Schultheiss & Hale, 2007; Schultheiss, Pang, Torges, Wirth, & Treynor, 2005). This latter point seems particularly relevant to children, since it is thought to result in experiencing feelings of subordination, causing the individual to become avoidant and submissive (e.g., Heuer et al., 2007). As researchers have highlighted, children will view adults as authority figures in most situations (Ceci, Ross, & Toglia, 1987; Goodman, 1984) since they learn to respect them through parental regulation (Milgram, 1974). As such, it could be that children in the present investigation viewed the NimStim photographs of adult faces as authority figures, thus resulting in feelings of subordination. Alternatively, it could be that happy faces are interpreted as mocking (Bradley et al., 1999; Vrticka, Andersson, Grandjean, Sander, & Vuilleumier, 2008; Yoon & Zinbarg, 2007). That said, it must be noted that these explanations are more relevant to social anxiety and that the pattern of happy face avoidance observed in this investigation was across all children and not only those with high levels of anxiety. In addition, all children avoided looking at either of the emotive face stimuli. Simply put, children avoided both angry and happy faces, but especially happy faces.

In relation to anxiety, a trend was observed in that HSA children made fewer initial fixations towards emotive faces per se than did LSA children in the 500 ms condition. Again, this does not support the hypothesis that high anxious children would make more initial orientations towards angry faces (i.e., hypothesis iii). However, an ET study by Garner et al. (2006) also revealed reduced biases in initial orienting for both positive and threatening faces in socially anxious adults. A more relevant study is that of Gamble and Rapee (2009), which found that anxious youth (i.e., children and adolescents) directed their first fixation away from both negative and positive faces. Whilst the present finding should be treated with caution given the small sample size, there are two possible explanations. Firstly, it could be that anxious individuals do not orient away from emotive faces, instead they orient towards neutral faces (Gamble & Rapee, 2009). As discussed in Chapter 4 [*see section 4.4*], neutral stimuli may be interpreted as threatening due to their ambiguous nature (e.g., see Amir, Foa, & Coles, 1998; Creswell, Schiering, & Rapee, 2005; MacLeod & Cohen, 1993). This may explain why all children and those with high levels of state anxiety oriented towards neutral faces on happy-neutral trials. However, it does not explain why HSA children directed their initial fixations towards neutral faces on angry-neutral trials, given that angry faces are more threatening.

A further possibility is that HSA children directed initial fixations away from emotive faces because such individuals are able to detect the affective content of stimuli without making overt, conscious eye movements. This early bias of attention has also been observed in Investigation Five of the present thesis [*see Chapter 6*] and supports the notion that anxious individuals are able to detect the emotive content of stimuli via shifts in covert attention. If this is the case, it is possible that this bias occurs in an attempt to decrease levels of anxiety (Gamble & Rapee, 2009). That said, all children avoided the emotive stimuli, although this effect was greater for the HSA children.

The findings that all children initially oriented towards and continued to fixate on angry faces during the 2000 ms condition supports hypothesis iii) (but not iv) [*see section 7.1*] and accords with a number of models purporting that attentional prioritisation for threat is an innate phenomenon linked to survival (Beck & Clark, 1997; Mogg & Bradley, 1998; Öhman, 1996; 2005; Williams, Watts, MacLeod, & Mathews, 1988). It is important to note that this finding relating to initial fixations differs to that demonstrated in the 500 ms condition, where it was revealed that: i) all children avoided happy faces to a greater extent than angry faces; and ii) HSA, relative to LSA, children showed a trend to avoid emotive

faces per se. This difference in findings dependent upon exposure is unexpected because evolutionary theorists would argue that anxiety-related biases in initial orienting should be present in both the 500 ms and the 2000 ms condition. One possible explanation for the discrepancy in initial orienting is that it was found that children were less likely to initiate an eye fixation within the time period of 500 ms, whilst 2000 ms allowed adequate time for this to occur. Indeed, it was observed that 653 first fixations were made during the 2000 ms condition, whilst only 275 were recorded in the 500 ms condition. As well as affecting the reliability of the results, this suggests that younger children cannot programme and make an eye movement within the first 200-500 ms of a stimulus appearing. As In-Albon et al. (2010) have stated, initial orienting may differ for children compared with adults given children's reduced cognitive-perceptual maturity and as such, the effect may not occur as rapidly as in adults. Further investigation is required to ensure comparable numbers of initial fixations per duration before more definite conclusions can be drawn.

To conclude, findings regarding the behavioural data revealed no differences in HTA compared with LTA eight to eleven year old children for the intermediate stimulus duration (500 ms). However, HTA children displayed a tendency not to engage attention with, or shift attention towards, angry faces presented for the longer stimulus duration (2000 ms). This offers partial support for several models of attentional bias and anxiety, more specifically, it offers support for the idea that greater elaborate processing of threat is avoided in an attempt to reduce subjective levels of anxiety. Of importance, this 'tendency not to engage' with angry faces could be one factor that subsequently leads to the development and maintenance of an anxiety disorder. However, findings regarding the ET data differed to those of the behavioural data. Here, it was found that all children initially avoided happy faces to a greater extent than angry faces in the 500 ms condition. In relation to anxiety, findings showed a trend towards HSA, relative to LSA, children orienting away from emotive faces per se. Findings for the 2000 ms exposure demonstrated that all participants directed initial fixations towards angry faces compared with happy faces and that this attentional bias towards angry faces continued for sustained attention. The differences in initial orienting between the 500 ms and the 2000 ms conditions may have been due to differences in the total numbers of initial fixations made. As such, it is necessary to conduct further research to ensure comparable numbers of initial fixations per duration before conclusions can be drawn. It is important to note that the current investigation only served as a pilot, and as such, sample size was also limited, particularly for the ET data. Indeed, to obtain an effect size of 0.30, power

analyses reveal that a sample of 26 is required as a very minimum. The issue of small sample size could account for both discrepant findings between the current and past research, as well as discrepant findings between the two different data types (i.e., behavioural versus eye-tracking).

CHAPTER 8

General Discussion

8.1 Introduction

In this thesis, a number of investigations into the effects of anxiety on visual attention for emotive stimuli in primary school children were presented. Importantly, these investigations spanned both the temporal and spatial domain to provide a comprehensive understanding of attentional bias. The purpose of the current chapter is to provide a general discussion of the thesis findings. Firstly, a brief outline of the underlying rationale will be provided, followed by a review of the investigations. This review includes a summary of the main findings, implications relating to past research/theory and clinical practice, and a discussion of the limitations and future directions. Concluding remarks will then be presented at the end.

8.2 Thesis Overview

There is now a plethora of research indicating that anxious adults exhibit biases of attention for threatening stimuli (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Cisler & Koster, 2010; Yiend, 2010, for reviews). The majority of these studies have focused on the spatial domain, revealing that different components of attentional bias may exist in relation to threat, these being **facilitated engagement**, **impaired disengagement** and **avoidance** [*see Table 8.1 for definitions*]. In anxious adults, facilitated engagement to threat has been consistently demonstrated in paradigms utilising short stimulus exposure durations (e.g., Byrne & Eysenck, 1995; Carlson & Reinke, 2008; Gilboa-Schechtman, Foa, & Amir, 1999; Juth, Lundqvist, Karlsson, & Öhman, 2005; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005; Miltner, Krieschel, Hecht, Trippe, & Weiss, 2004; Rinck, Becker, Kellermann, & Roth, 2003; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005), while impaired disengagement from threat has been evidenced in research incorporating a range of stimulus presentation times (e.g., Amir, Elias, Klumpp, & Przeworski 2003; Cisler &

Olatunji, 2012; Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Koster, Crombez, Verschuere, & De Houwer, 2006; Koster, Crombez, Verschuere, & De Houwer, 2004; Lipp & Waters, 2007; Salemink, van den Hout, & Kindt, 2007; Van Damme, Crombez, Hermans, Koster, & Eccleston, 2006; Yiend & Mathews, 2001). Avoidance of threat, however, has only been reported in studies utilising longer stimulus exposure durations, and findings here are equivocal (e.g., Bradley, Mogg, Falla, Hamilton, 1998; Calvo & Avero, 2005; Garner, Mogg, & Bradley, 2006; Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2005; Koster, Verschuere, Crombez, & Van Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004; Pflugshaupt et al., 2005; Rohner, 2002).

A more recent line of attentional bias enquiry is research into the temporal domain of attention. In adults, this has also demonstrated facilitated engagement towards threat in clinically anxious (i.e., specific phobia; D'Alessandro, Gemignani, Castellani, & Sebastiani, 2009; Reinecke, Rinck, & Becker, 2008; Trippe, Hewig, Heydel, Hecht, & Miltner, 2007) and non-clinically anxious populations (i.e., state and/or trait anxiety; Arend & Botella, 2002; Barnard, Ramponi, Battye, & Mackintosh, 2005; Fox, Russo, & Georgiou, 2005; Vaquero, Frese, Lupianez, Megias, & Acosta, 2006). In relation to impaired disengagement, however, findings are currently mixed (Amir, Taylor, Bomyea, & Badour, 2009; Arend & Botella, 2002; Barnard et al., 2005; Cisler, Ries, & Widner, 2007; de Jong, Koster, van Wees, & Martens, 2009; de Jong & Martens, 2007; Peers & Lawrence, 2009; Lystad, Rokke, & Stout, 2009).

Table 8.1

Definitions of the Components of Attentional Bias

Component	Definition
Facilitated engagement	The selection and preferential processing of a specific stimulus type (e.g., threatening).
Impaired disengagement	Difficulty in withdrawing attention (i.e., terminating selection and preferential processing) from a specific stimulus type.
Avoidance	Allocating attention towards locations other than the location of a specific stimulus type.

Several theories have now been developed to explain the different components of attentional bias. To recap, these suggest that attention for threat is guided by automatic processes and that anxiety causes heightened sensitivity to threat, thus resulting in a greater attentional bias towards this stimulus type (Beck & Clark, 1997; Mathews, Mackintosh, & Fulcher, 1997; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman, 1996; 2005; Williams, Watts, MacLeod, & Mathews, 1988; *cf.* Well & Matthews, 1994). It has further been theorised that anxiety leads to elaboration of this information (i.e., impaired disengagement), which is considered to be detailed and effortful (Beck & Clark, 1997). However, Mogg and Bradley (1998) argue that after initial orientation, subsequent detailed processing of this information is avoided in an attempt to reduce anxiety levels (i.e., avoidance).

To sum, whilst it is clear that attentional bias for threat in anxiety is a major focus of research, few studies to date have investigated this area in child populations. Furthermore, the majority of theoretical models in this area have concerned adults. This is despite research demonstrating that symptoms relating to clinical and non-clinical anxiety follow a stable course from childhood (earlier than two years of age; Kagan, Kearsly, & Zezalo, 1978) through to adolescence and adulthood. As such, there was a need to conduct further research in this area with children, hence the main aim of the present research thesis.

Also, an advantage of the present thesis was that it included biologically relevant stimuli (i.e., emotive facial expressions), which have been found to promote attentional prioritisation (LeDoux, 1996; Öhman, 1996). The current research also controlled for levels of dysphoria, which is important given that anxiety and depression are thought to differ in respect to attentional allocation (e.g., see Mogg & Bradley, 2005).

In order to provide a comprehensive investigation of the effects of state and trait anxiety on visual attention for emotive stimuli in children, both rapid serial visual presentation (RSVP) with the attentional blink (AB), and the visual probe (VP) paradigm were utilised to account for temporal and spatial biases of attention, respectively. In relation to temporal attention, the main objective was to determine whether children with high, relative to low, levels of anxiety demonstrated facilitated engagement to, and/or impaired disengagement from, threatening stimuli. Regarding spatial attention, the main objective was to establish whether children with high, relative to low levels of anxiety displayed facilitated engagement to, impaired disengagement from, and/or avoidance of, threatening stimuli.

8.3 Summary of Main Findings

Chapters 3, 4, and 5 presented four AB studies that were pursued in order to investigate the effects of anxiety on the **temporal** domain of attention in children. Utilising an RSVP paradigm allowed for the investigation of both facilitated engagement and impaired disengagement. In Chapters 6-7, VP tasks were utilised to examine the effects of anxiety on **spatial** biases of attention in children. The specific VP paradigm employed allowed for the investigation of all three components of attentional bias; that is, facilitated engagement, impaired disengagement and avoidance. In addition, as stimulus duration was also manipulated, it was further possible to investigate components of both **covert** (Investigation Five, Chapter 6) and **overt** attention (Investigation Six, Chapter 7). In this final study, the VP paradigm was combined with eye tracking (ET) in order to provide a more direct and ecologically valid measure of the time course of spatial attention. The main findings of these studies are summarised below.

In Investigation One (Chapter 3), non-emotive version of the AB task was employed to determine whether levels of anxiety affect eight to eleven year old children's processing speed per se and the manifestation of the AB. Findings from this first investigation demonstrated that participants were worse at detecting both targets in an RSVP stream when the second target (T2) appeared within the typical blink period, that is, within 200-400 milliseconds (ms). Participants' performance improved when the T2 appeared outside of the typical blink period. However, there were no effects of state or trait anxiety in this task. To sum, Investigation One revealed that eight to eleven year old children are subject to the same processing constraints as adults and, additionally, provided evidence that RSVP with the AB can be reliably utilised with children to investigate processes of attention and emotion.

Following on from this, three emotive versions of the AB task were employed in an attempt to investigate both facilitated engagement to, and impaired disengagement from, threat. Investigation Two (Chapter 3) revealed that findings were confounded by task difficulty and as such, a second investigation (Investigation Three, Chapter 4) was conducted with a different child population utilising simplified distracter stimuli to decrease task difficulty. This demonstrated that **high trait anxiety** was associated with **facilitated engagement** towards **angry** compared with neutral and happy, faces. In addition, **high trait anxious** (HTA), relative to low trait anxious (LTA), children displayed **facilitated engagement** to **neutral** facial expressions. However, in Investigation Four (Chapter 5),

where the emotive stimulus was presented as the first target, no effects of impaired disengagement were observed – instead, it was found that **all** children *rapidly disengaged* temporal attention from angry, relative to happy and neutral, facial expressions.

Investigation Five (Chapter 6), which was the first VP study of the present thesis, involved examining the effects of anxiety on **covert** attention for threat in eight to eleven year old children. Here, it was observed that **high trait anxiety**, relative to low trait anxiety, was associated with an attentional bias **away** from **happy** faces in comparison to angry faces. This attentional bias was found to consist equally of a **tendency not to engage** with, *and avoidance* of, happy faces and suggests that as well as not engaging attention with positive faces, anxious children also diverted attention towards an opposing spatial location (i.e., a neutral face).

During the investigation of **overt** attention (Investigation Six, Chapter 7), behavioural (i.e., reaction time [RT]) data revealed that **HTA**, relative to LTA, children displayed a **later** bias of attention (i.e., at 2000 ms) **away** from **angry** faces compared with happy faces. This attentional bias was found to consist of a **tendency not to engage** with angry faces rather than allocating attention to a competing stimulus (i.e., the neutral face). In this investigation, eye movements during VP task performance were also measured. This data revealed that **all** children: i) displayed initial greater **avoidance** of **happy** faces presented in the **500 ms** condition; and ii) attended **towards angry** faces throughout the **2000 ms** exposure duration. In relation to anxiety, it was found that those with high levels of state anxiety **avoided** both **angry and happy** faces during the **500 ms** stimulus presentation condition to a greater extent than LSA children. However, it is important to acknowledge that in this final study the participant sample size was limited.

In both VP tasks (i.e., Investigations Five and Six, Chapters 6-7), subjective appraisal data were additionally obtained for the stimuli utilised. This data revealed that all children gave the lowest ratings (i.e., ‘very nervous’; ‘very unpleasant’) for the angry facial expressions and the highest ratings (i.e., ‘very relaxed’; ‘very pleasant’) for the happy faces on both the arousal and valence scales. Also, worthy of note is that the neutral faces were consistently rated within the midpoint of the scale (i.e., 42-55%).

Whilst levels of AC were also measured, these were not included in the main analyses given that AC is thought to be linked to problems in disengagement from threatening stimuli (Cisler & Koster, 2010) – a component of attentional bias that was not apparent in the current research. That said, it was observed that children with high levels of trait/state anxiety

typically possessed high levels of AC, whilst those with low levels of trait/state anxiety typically possessed low levels of AC.

8.4 Implications

8.4.1 Past Research and Theoretical Models

The finding that HTA children displayed facilitated engagement to threat in the temporal domain is not only consistent with adult AB studies (Barnard et al., 2005; D'Alessandro et al., 2009; Fox et al., 2005; Reinecke et al., 2008; Trippe et al., 2007; Vaquero et al., 2006), but also offers support for the following theories of attentional bias and anxiety: Beck and Clark's (1997) 'information processing model'; Mogg and Bradley's (1998) 'cognitive-motivational model'; and Öhman's (1996, 2005) 'feature detection model'. According to these models, attentional bias for threat is innate and occurs at an automatic/unconscious level because it has developed to maintain survival [*see Chapter 1, section 1.2.1 for further discussion*]. These models further propose that attention to threat is moderated according to anxiety level. In particular, Mogg and Bradley (1998) claim that the threat value of a stimulus is evaluated differently depending on trait anxiety, such that high trait anxiety results in an increased sensitivity to threat. These authors go on to suggest that differences in attentional allocation to threat in HTA and LTA individuals can be expected for mild, but not severe, threat. This theory therefore further offers an explanation for the present finding related to neutral faces, as according to research by Lee, Kang, Park, Kim and An (2008), neutral faces can be interpreted as negative.

The finding that all children rapidly disengaged attention from angry faces in the temporal domain also accords well with the cognitive and neurobiological models of attentional bias presented, since these propose that the rapid identification of threat enables the early activation of defence mechanisms (LeDoux, 1996; Öhman, 1996). It also extends recent research by Maratos (2011), which demonstrated that adults displayed a more rapid recovery from the blink effect following angry, compared with neutral or happy schematic faces. That is, adults were faster to disengage attention from threat and shift attentional resources to new information. The current research indicated that a similar mechanism linked to rapid threat processing exists in children.

The later, overt bias of spatial attention away from angry faces for the HTA children demonstrated in the second VP study (i.e., Investigation Six, Chapter 7) offers support for the second stage of Mogg and Bradley's (1998) cognitive-motivational model and similar theories (Mogg & Bradley, 1998; Mogg, Bradley, de Bono, & Painter, 1998; Mogg, Mathews, & Weinman, 1987). These argue that detailed analysis of threat, which involves top-down processes, is avoided in order to decrease subjective levels of anxiety. Whilst findings relating to the ET data are inconsistent with this (in demonstrating that all children attended towards angry faces throughout the 2000 ms exposure duration), it must be remembered that for this investigation the sample size was limited.

The findings that HTA children both covertly biased their attention away from happy faces (Investigation Five, Chapter 6), as well as directed initial eye fixations away from such stimuli (Investigation Six, Chapter 7) were unexpected and do not accord with previous literature. As such, and despite this finding being observed across two of the present studies, these findings offer no support for the theoretical models of attentional bias and anxiety as outlined in Chapter 1 [*see section 1.3.3*]. To recap, the main tenet of these theories concerns attention towards threatening stimuli (and not those that are positive). Thus, these theories do not adequately explain the processes of attentional bias observed in children within this thesis.

The present thesis findings are, however, in line with VP studies of *social* anxiety. Here, social phobia is linked to preferentially allocating attention away from positive stimuli (Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, Ehlers, & Chen, 1999; Pishyar, Harris, & Menzies, 2004; Taylor, Bomyea, & Amir, 2010). One explanation given for this positive stimulus avoidance bias is that happy faces may signify social dominance to those with high levels of social anxiety, which could in turn lead to feelings of subordination (Hess, Adams, & Kleck, 2005; Hess, Blairy, & Kleck, 2000; Heuer, Rinck, & Becker, 2007; Schultheiss & Hale, 2007; Schultheiss, Pang, Torges, Wirth, & Treynor, 2005). It is argued that avoidance of such stimuli may reflect defensive efforts to reduce levels of anxiety (Berenson et al., 2009). From the results of the present thesis, it is evident that this explanation and variations of it [*see Chapter 6, section 6.4*] should be expanded to childhood anxiety in general. Indeed, from a social perspective, children are more likely to find themselves in situations in which obedience to authority is probable due to their socialisation to respect authority (Meyer & Jesilow, 1997). Of note, children will view adults as authority figures in most circumstances (Ceci, Ross, & Toglia, 1987; Goodman, 1984) because they

learn through parental regulation that adults should be respected (Milgram, 1974). Thus in future models of attentional bias and anxiety, especially where children are concerned, it is recommended that an explanation of the early attentional bias away from happy faces is included.

Across Investigations Five and Six, a final finding was that children with high levels of state or trait anxiety typically possessed low levels of AC, whereas children with low levels of state or trait anxiety typically possessed high levels of AC. Of note, this accords with the assumption of Eysenck, Derakshan, Santos, and Calvo (2007) that higher levels of anxiety decrease the two functions of executive control associated with AC, i.e., attentional inhibition / shifting. Thus, it may be the case that higher levels of anxiety: i) reduce the degree to which inhibitory mechanisms are able to regulate automatic responses; and ii) increase the degree to which attention is shifted from one task to another. Future research should include measures of AC to both seek to replicate the present findings as well as test whether AC is also associated with impaired disengagement from threat (should this finding emerge).

8.4.2 Clinical Practice

The finding that anxious adults exhibit cognitive (i.e., attention, interpretation, and memory) biases towards threat has led to the development of treatment paradigms that aim to reduce these biases. One such treatment is cognitive behavioural therapy (CBT), which has been demonstrated to be highly effective, particularly in adults (Barlow, 2001). In brief, CBT typically involves altering maladaptive assumptions by suggesting more rational ones, and helping patients to identify their anxiety symptoms and respond in a more appropriate manner. A limitation of CBT, however, is that it does not tend to address biases of attention, despite these being consistently demonstrated in literature concerning anxious adults (see Bar-Haim et al., 2007; Cisler & Koster, 2010; Yiend, 2010, for reviews) and more recently, in child studies. This may be a reason why approximately 30-40% of children currently treated for anxiety continue to experience the disorder (Waters, Pittaway, Mogg, Bradley, & Pine, 2013). As such, researchers have begun to develop a treatment referred to as attentional bias modification (ABM). This was originally developed by Wells (2000) to address the deficits proposed in the ‘Self-Regulatory Executive Function’ (Wells & Mathews, 1994) model [*see Chapter 1, section 1.3.3.1 for further details*]. ABM involves adapting the most frequently applied experimental paradigms utilised in identifying information processing

biases (i.e., the emotional Stroop and visual probe tasks) to train anxious individuals to attend to neutral, as opposed to threatening, stimuli. Thus far, ABM has been shown to effectively diminish both threat-related attentional bias and anxiety symptoms in adults with high trait anxiety, generalised anxiety disorder or social phobia (see Bar-Haim, 2010; MacLeod & Mathews, 2012 for reviews). This form of treatment is advantageous since it is as effective as traditional procedures, yet requires less resources and time (Coward & Ollendick, 2010).

Given that the present emotive AB research (Investigations Three and Four) demonstrated that anxious children also display facilitated engagement towards threat, it is reasonable to assume that ABM treatment could also be beneficial in child samples. Currently, however, RSVP paradigms are not utilised to modify attentional bias in anxiety and thus, no studies have focused on retraining *temporal* biases of attention. As such, a recommendation from this thesis research is the use of RSVP with the AB in ABM therapy to train anxious adults and children to allocate temporal attention towards non-threatening, relative to threatening, stimuli. There are a number of ways in which this could be achieved. For example, angry facial expressions could be included as the distracters and non-threatening faces as the target stimuli. However, as this thesis further found that HTA children demonstrated facilitated engagement to neutral faces (possibly due to threat interpretation), it may not be appropriate to include these as the non-threatening targets. Rather, it may be more suitable to train anxious children to allocate attention towards happy faces when retraining biases in the temporal domain.

The present findings that HTA children demonstrate both a covert and an early attentional bias away from happy facial expressions in the spatial domain also offer important implications for clinical practice. Recent adult studies utilising ABM to train spatial attention away from threat have demonstrated promising results in reducing anxiety (Amir, 2006; Amir, Beard, Cobb, & Bomyea, 2009; Amir, Weber, Beard, Bomyea, & Taylor, 2008; Hazen, Vasey, & Schmidt, unpublished, as cited in Coward & Ollendick, 2010; MacLeod & Bridle, 2006; Richey & Schmidt, 2006). For example, Hazen et al. (unpublished, as cited in Coward & Ollendick, 2010) developed Attentional Retraining for Threat Stimuli (ARTS) to moderate attentional bias towards threatening stimuli in pathological adult worriers. ARTS consisted of a computerised, modified version of the VP paradigm where probes followed neutral rather than threatening words. In a preliminary investigation, adults experiencing high levels of worry were treated with 30 minute sessions of ARTS, typically with a six day period in between sessions. A control group were also included and these individuals received a sham-

ARTS condition, which consisted of a VP task in which the probes followed both neutral and threatening words with equal frequency. After one week, it was found that participants in the ARTS condition displayed diminished attentional bias for threat, as well as reduced levels of anxiety. In contrast, the control group did not demonstrate any such improvements.

In regards to anxious children, it appears that only two studies have investigated the success of utilising ABM in biasing attention away from threat (Bar-Haim, Morag, & Glickman, 2011; Eldar et al., 2012). While findings have demonstrated some efficacy, they also suggest that biases of attention towards threat are only present in a sub-set of anxious children (Eldar et al., 2012). Thus, training those who enter treatment with no threat bias may be unnecessary and possibly even detrimental, leading to the exacerbation of anxiety (Eldar et al., 2012; Cowart & Ollendick, 2011). As Waters et al. (2013) suggest, it may be more fruitful to train anxious children to preferentially allocate attention towards positive stimuli. Findings from the present thesis accord with this view, especially as a prominent finding was that HTA children bias their attention away from such stimuli.

Of relevance, a study by Dandeneau, Baldwin, Baccus, Sakellaropoulo and Pruessner (2007) has assessed the effects of training attention towards positive stimuli. However, this was in healthy adults. Briefly, the study involved utilising a visual-search paradigm in which participants were required to search for a single smiling face embedded within fifteen disapproving faces. In a control condition, participants searched for one particular flower embedded amongst others. Those who took part in the positive-training condition displayed reduced physiological stress reactivity and reported experiencing significantly less stress compared with those in the control. Importantly, this study demonstrates that: i) VP paradigms can be successfully utilised to both retrain attentional bias and relieve anxiety symptoms; and ii) training individuals to allocate attention towards positive stimuli reduces anxiety and stress levels. Given this and findings that HTA children allocate their spatial attention away from happy faces (Investigations Five and Six), there is potential to modify these biases and importantly, reduce early anxiety symptomology. This could be achieved by modifying a VP paradigm so that probes are weighted to follow positive facial expressions more frequently than neutral faces.

In relation to later attentional bias, Investigation Six demonstrated that children with high levels of trait anxiety tended not to engage with angry faces presented for 2000 ms. Although avoidance of threat may reduce anxiety levels in the short term, this bias prevents anxious individuals from challenging negative beliefs and reappraising situations

accordingly. By contrast, attending to threat allows exposure to this stimulus type, thus providing the opportunity for anxious individuals to make more rational appraisals (Hudson & Rapee, 2004; Rapee, 2001). As such, it may be beneficial to train anxious children to continue attending to threat by modifying a VP paradigm so that probes are weighted to follow angry faces more so than neutral faces but only after **long** stimulus exposure durations. That said, it is important to note that initial findings relating to ET data in this investigation suggest that all children attended towards angry faces throughout a 2000 ms exposure duration, which is in disagreement with the behavioural findings. Thus, before the current results from the VP studies are utilised to inform any such VP based cognitive therapies for the treatment of threat biases in childhood anxiety, it may be necessary to conduct further research.

8.5 Limitations and Future Directions

When considering research into the temporal domain of attention, a possible limitation of the AB task utilised in the present thesis is that it was confounded by task difficulty (despite the task having been simplified in Investigation Three). This may have masked any interaction effects between the duration of the AB, the emotive content, and the affective state of the individual [*see Chapter 4, section 4.4 for further discussion*]. As such, the AB task employed in the present thesis research should be further simplified in future research involving children. One way this can be achieved is by ensuring that targets are even more dissimilar to distracter items.

In addition, the finding that HTA participants displayed an attentional bias for neutral stimuli in the temporal domain was unexpected and suggests that an interpretation bias may also exist in children. To investigate this further, it is advisable for future AB studies to seek replication of this finding in both adult and child populations. It may also be beneficial to collect arousal and valence ratings for the schematic stimuli incorporated in this part of the thesis. Should the current facilitated engagement to neutral faces finding be replicated and the neutral faces be rated as threatening/negative, this raises the important questions of whether the two biases (i.e., attentional and interpretational) are intricately linked in children and if so, how. According to Hirsch, Clark, and Mathews (2006), one bias directly influences the other and this has recently been observed in studies of anxious adults (e.g., Amir, Bomyea, & Beard, 2010; White, Suway, Pine, Bar-Haim, & Fox, 2011). Thus, this should also be an area

of future investigation in children following on from this thesis [see Chapter 4, section 4.4 for further discussion].

A further recommendation for future research involving RSVP style emotive paradigms is that measures of attentional control (AC) are taken. This is because it has been posited that AC may be a possible mechanism that mediates difficulties in disengaging attention from threat (Eysenck et al., 2007).

A limitation of the overt VP research (Investigation Six, Chapter 7) is that it can only serve as a pilot given that the sample sizes were limited for both the behavioural ($N = 20$) and the ET ($N = 12$) data. Indeed, power analyses have revealed that a sample size of at least 26 participants is required to obtain an effect size of 0.30. As such, it is necessary to expand this investigation in order to determine whether the findings demonstrated here are valid.

In addition, as the finding that HTA children exhibited an early attentional bias away from happy faces in both the covert and overt VP tasks (Investigation Five, Chapter 6; and Investigation Six, Chapter 7) accords with studies and theories relating to *social phobia*, it may be beneficial to include measures of this specific anxiety disorder in future child studies. Indeed, it could be the case that an attentional bias away from positive stimuli is linked to social phobia rather than trait anxiety per se.

A final recommendation for further research into spatial attentional bias is the inclusion of an emotion regulation measurement, since emotion regulation is posited to be linked to avoidance (Cisler & Koster, 2010), which was observed in Investigations Five and Six of the present research.

8.6 Conclusions

The main aim of the present thesis was to investigate the effects of trait and state anxiety on visual attention for emotive stimuli in primary school children. In order to provide a more comprehensive overview, both RSVP (with the AB) and VP paradigms were incorporated, which allowed for investigations of temporal and spatial biases of attention, respectively. The first main objective of this research was to determine whether children with high, relative to low, levels of anxiety displayed facilitated engagement to and/or impaired disengagement from threat in the temporal domain. A second objective was to determine whether children with high, relative to low, levels of anxiety displayed facilitated engagement to, impaired disengagement from and/or avoidance of threat in the spatial domain.

Findings in relation to temporal attention demonstrated that high trait anxiety was associated with: i) facilitated engagement towards angry faces; and ii) facilitated engagement towards neutral faces. It was further found that all children rapidly disengaged attention away from angry faces. In regards to spatial attention, results revealed that high trait anxiety was linked to: i) an early, covert bias of attention away from happy faces; and ii) a later, overt bias of attention away from angry faces. Finally, eye movement data revealed mixed findings but this was possibly due to the limited sample size.

Taken together, the above findings offer important implications for past research and theoretical models of attentional bias and anxiety. Although some of the models (i.e., Öhman 1996, 2005; Beck & Clark, 1997; Mogg & Bradley, 1998; Williams et al., 1988) imply that attentional bias for threat is an innate phenomenon that is present during early childhood and moderated by anxiety level, none of them *explicitly* account for developmental aspects. Thus, based on the findings from this thesis, it is necessary for future models to make the link between attentional bias for threat in anxiety and children more clear. Furthermore, the current thesis findings demonstrate that there is a need for future models to include components that account for an attentional bias towards neutral faces and an attentional bias away from happy faces in anxious children.

Leading on from research presented in this thesis it is further argued that in future clinical practice, ABM paradigms are developed that train anxious children to allocate attention towards: i) non-threatening (i.e., happy), relative to threatening stimuli, in the temporal domain; and ii) happy faces in the spatial domain. Such ABM paradigms are likely to be beneficial in re-training attentional bias and subsequently reducing (or alleviating) anxiety. One feasible way in which ABM treatment programs could achieve this is by modifying the RSVP (with the AB) and VP paradigms designed and utilised in this thesis, respectively.

References

- Adams, R. B., Jr., Ambady, N., Macrae, C. N., & Kleck, R. E. (2006). Emotional expressions forecast approach-avoidance behaviour. *Motivation and Emotion*, 30, 179-188.
- Adolphs, R. (2002). Recognising emotion from facial expressions: Psychological and neurological mechanisms. *Behavioural Cognitive Neuroscience Reviews*, 1, 21-61.
- Adolphs, R. (2003). Cognitive neuroscience of human social behaviour. *Nature Reviews Neuroscience*, 4, 165-178.
- Alden, L. E., Taylor, C. T., Mellings, T. M. J., & Laposa, J. M. (2008). Social anxiety and the interpretation of positive events. *Journal of Anxiety Disorders*, 21, 850-866.
- Algom, D., Chajut, E., & Lev, S. (2004). A rational look at the emotional Stroop phenomenon: A generic slowdown, not a Stroop effect. *Journal of Experimental Psychology: General*, 133, 323-338.
- Alpers, G. W., & Gerdes, A. B. M. (2007). Here's looking at you: Emotional faces predominate in binocular rivalry. *Emotion*, 7, 495-506.
- American Psychiatric Association (APA) (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC, USA: Author.
- Amir, N. (2006, September). Modification of attentional bias in social phobia: Change in attention, generalizability across paradigms, and change in symptoms. In C. Hirsch (Chair), *New advances in the facilitation of benign cognitive biases*. Symposium conducted at the annual meeting of the European Association for Cognitive and Behavioral Therapies, Paris, France.
- Amir, N., Beard, C., Cobb, M., & Bomyea, J. (2009). Attention modification program in individuals with Generalized Anxiety Disorder. *Journal of Abnormal Psychology*, 118, 28-33.

Amir, N., Bomyea, J., & Beard, (2010). The effect of single-session interpretation modification on attention bias in socially anxious individuals. *Journal of Anxiety Disorders*, 24(2), 178-182.

Amir, N., Elias, J., Klumpp, H., & Przeworski, A. (2003). Attentional bias to threat in social phobia: Facilitated processing of threat or difficulty disengaging attention from threat? *Behaviour, Research and Therapy*, 41, 1325-1335.

Amir, N., Foa, E. B., & Coles, M. E. (1998). Negative interpretation bias in social phobia. *Behaviour Research and Therapy*, 36, 945-957.

Amir, N., Taylor, C., Bomyea, J., & Badour, C. (2009). Temporal allocation of attention toward threat in individuals with posttraumatic stress symptoms. *Journal of Anxiety Disorders*, 23, 1080-1085.

Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. (2008). The effect of a single session attention modification program on response to a public speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology*, 117, 860-868.

Anderson, A. K. (2005). Affective influences on the attentional dynamics supporting awareness. *Journal of Experimental Psychology*, 134(2), 258-281.

Anderson, A. K., & Phelps, E. A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature*, 411(6835), 305-309.

Arend, I., & Botella, J. (2002). Emotional stimuli reduce the attentional blink in sub-clinical anxious subjects. *Psicothema*, 14(2), 209-214.

Asendorpf, J. B., Denissen, J. J. A., & van Aken, M. A. G. (2008). Inhibited and aggressive preschool children at 23 years of age: personality and social transitions into adulthood. *Developmental Psychology*, 44, 997-1011.

- Aslin, R. N., & McMurray, B. (2004). Automated corneal-reflection eye tracking in infancy: Methodological developments and applications to cognition. *Infancy*, 6(2), 155-163.
- Bannerman, R., Milders, M., de Gelder, B., & Sahraie, A. (2008). Influence of emotional facial expressions on binocular rivalry. *Ophthalmic and Physiological Optics*, 28, 317-326.
- Bar-Haim, Y. (2010). Research Review: attention bias modification (ABM): A novel treatment for anxiety disorders. *Journal of Child Psychology and Psychiatry*, 51(8), 859-870.
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and non-anxious individuals: A meta-analytic study. *Psychological Bulletin*, 133(1), 1-24.
- Bar-Haim, Y., Morag, I., & Glickman, S. (2011). Training anxious children to disengage attention from threat: A randomized controlled trial. *Journal of Child Psychology and Psychiatry*, 52, 861-869.
- Barlow, D. H. (2001). *Clinical handbook of psychological disorders: A step-by-step treatment manual*. New York, USA: Guilford Press.
- Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic* (2nd ed.). New York, USA: Guilford Press.
- Barnard, P., Ramponi, C., Battye, G., & Mackintosh, B. (2005). Anxiety and the deployment of visual attention over time. *Visual Cognition*, 12(1), 181-211.
- Barrett, P. M., Rapee, R. M., Dadds, M. R., & Ryan, S. M. (1996). Family enhancement of cognitive style in anxious and aggressive children. *Journal of Abnormal Child Psychology*, 24, 187-203.
- Barrett, L. F., & Russell, J. A. (1999). Structure of current affect. *Current Directions in Psychological Science*, 8, 10-14.

Bauer, D. H. (1976). An exploratory study of developmental changes in children's fears. *Journal of Child Psychology and Psychiatry*, 17, 69-74.

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy*, 35, 49-58.

Beck, A. T., Emery, G., & Greenberg, R. L. (1985). *Anxiety disorders and phobias: A cognitive perspective*. New York, USA: Basic Books.

Beck, A. T., Steer, R., Kovacs, M., & Garrison, B. (1985). Hopelessness and eventual suicide: A 10-year prospective study of patients hospitalised with suicidal ideation. *American Journal of Psychiatry*, 142, 559-563.

Beesdo, K., Knappe, S., & Pine, D. S. (2011). Anxiety and anxiety disorders in children and adolescents: Developmental issues and implications for DSM-V. *Psychiatric Clinics of North America*, 32(3), 483-524.

Bell-Dolan, D. J. (1995). Social cue interpretation of anxious children. *Journal of Clinical Child Psychology*, 24, 1-10.

Bengtsson, H. (2005). Children's cognitive appraisal of others' distressful and positive experiences. *International Journal of Behavioural Development*, 29, 457-466.

Benoit, K. E., McNally, R. J., Rapee, R. M., Gamble, A. L., Wiseman, A. L. (2007). Processing of emotional faces in children and adolescents with anxiety disorders. *Behaviour Change*, 24(4), 183-194.

Berenson, K. R., Gyurak, A., Ayduk, O., Downey, G., Garner, M., Mogg, K., Bradley, B. P., & Pine, D. S. (2009). Rejection sensitivity and disruption of attention by social threat cues. *Journal of Research in Personality*, 43, 1064-1072.

Blake, R. (1989). A neural theory of binocular rivalry. *Psychological Review*, 96, 145-167.

Bornstein, M. H., & Lamb, M. E. (2011). *Developmental science* (6th ed.). New York, USA: Psychology Press.

Bögels, S. M., & Mansell, W. (2004). Attention processes in the maintenance and treatment of social phobia: Hypervigilance, avoidance and self-focused attention. *Clinical Psychology Review*, 24(7), 827-856.

Bögels, S. M., & Zigterman, D. (2000). Dysfunctional cognitions in children with social phobia, separation anxiety disorder, and generalised anxiety disorder. *Journal of Abnormal Child Psychology*, 28, 205-211.

Borkovec, T., Robinson, E., Pruzinsky, T., & Depree, J. (1983). Preliminary exploration of worry: Some characteristics and processes. *Behaviour Research and Therapy*, 21, 9-16.

Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, I. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion*, 12, 737-753.

Bradley, B. P., Mogg, K., & Lee, S. C. (1997). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy*, 35(10), 911-927.

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety. *Cognition and Emotion*, 14(6), 789-808.

Bradley, B. P., Mogg, K., White, J., Groom, C., & de Bono, J. (1999). Attentional bias for emotional faces in generalised anxiety disorder. *British Journal of Clinical Psychology*, 38, 267-278.

Broadbent, D. E., & Broadbent, M. H. P. (1987). From detection to identification: Response to multiple targets in rapid serial visual presentation. *Perception & Psychophysics*, 42(2), 105-113.

- Brotman, M. A., Rich, B. A., Schmajuk, M., Reising, M., Monk, C. S., Diskstein, D. P., Mogg, K., Bradley, B. P., Pine, D. S., & Leibenluft, E. (2007). Attention bias to threat faces in children with bipolar disorder and comorbid lifetime anxiety disorders. *Biological Psychiatry*, 61(6), 819-821.
- Byrne, A., & Eysenck, M. W. (1995). Trait anxiety, anxious mood and threat detection. *Cognition and Emotion*, 9, 549-562.
- Calvo, M. G., & Avero, P. (2005). Time course of attentional bias to emotional scenes in anxiety: Gaze direction and duration. *Cognition and Emotion*, 19, 433-451.
- Calvo, M. G., & Esteves, F. (2005). Detection of emotional faces: Low perceptual threshold and wide attentional span. *Visual Cognition*, 12, 13-27.
- Campbell, D. W., Sareen, J., Stein, M. B., Kravetsky, L. B., Paulus, M. P., Hassard S. T., & Reiss, J. P. (2009). Happy but not so approachable: The social judgments of individuals with generalised social phobia. *Depression and Anxiety*, 26, 419-424.
- Carlson, J. M., & Reinke, K. S. (2008). Masked fearful faces modulate the orienting of covert spatial attention. *Emotion*, 8, 522-529.
- Carrasco, M. (2011). Visual attention: The past 25 years. *Vision Research*, 51, 1484-1525.
- Caseras, X., Garner, M., Bradley, B. P., & Mogg, K. (2007). Biases in visual orienting to negative and positive scenes in dysphoria: An eye movement study. *Journal of Abnormal Psychology*, 116(3), 491-497.
- Castaneda, A., McCandless, B. R., & Palermo, D. S. (1956). The Children's Form of the Manifest Anxiety Scale. *Child Development*, 27(3), 317-326.
- Ceci, S. J., Ross, D. F., Toglia, M. P. (1987). Suggestibility of children's memory: Psycholegal implications. *Journal of Experimental Psychology*, 16, 38-49.

Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: The perception-behaviour link and social interaction. *Journal of Personality and Social Psychology*, 76(6), 893-910.

Chen, Y. P., Ehlers, A., Clark, D. M., & Mansell, W. (2002). Patients with generalized social phobia direct their attention away from faces. *Behaviour Research and Therapy*, 40(6).

Cheung, V., Chen, E. Y. H., Chen, R. Y. L., Woo, M. F., & Yee, B. K. (2002). A comparison between schizophrenia patients and healthy controls on the expression of attentional blink in a rapid serial visual presentation (RSVP) paradigm. *Schizophrenia Bulletin*, 28(3), 443-458.

Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, 21, 109-127.

Ciesielski, B. G., Armstrong, T., Zald, D. H., & Olatunji, B. O. (2010). Emotion modulation of visual attention: Categorical and temporal characteristics. *Emotion and Attention*, 5(11), 1-6.

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, 30, 203-216.

Cisler, J. M., & Olatunji, B. O. (2010). Components of attentional biases in contamination fear: Evidence for difficulty in disengagement. *Behaviour Research and Therapy*, 48, 74-78.

Cisler, J. M., Ries, B. J., & Widner, R. L., Jr. (2007). Examining information processing biases in spider phobia using the rapid serial visual presentation paradigm. *Journal of Anxiety Disorders*, 21, 977-990.

Charman, T., & Pervova, I. (2000). The internal structure of the Child Depression Inventory in Russian and UK school children. *Journal of Youth and Adolescence*, 30(1), 41-51.

Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, 21, 109-127.

Cooper, R. M., & Langton, S. R. H. (2006). Attentional bias to angry faces using the dot-probe task? It depends when you look for it. *Behaviour Research and Therapy*, 44, 1321-1329.

Cowart, M. J. W., & Ollendick, T. H. (2010). Attentional biases in children: Implications for treatment. In J. A. Hadwin, & A. P. Field (Eds.), *Information processing biases and anxiety. A developmental perspective* (pp. 129-149). Chichester, UK: Wiley-Blackwell.

Craighead, W. E., Curry, J. F., & Ilardi, S. S. (1995). Relationship of Children's Depression Inventory factors to major depression among adolescents. *Psychological Assessment*, 7(2), 171-176.

Creswell, C., Schiering, C. A., & Rapee, R. M. (2005). Threat interpretation in anxious children and their mothers: Comparison with nonclinical children and the effects of treatment. *Behaviour Research and Therapy*, 43, 1375-1381.

Crocker, S., & Maratos, F. A. (2011). Visual processing speeds in children. *Child Development Research*, Article ID 450178.

D'Alessandro, L., Gemignani, E., Castellani, E., & Sebastiani, L. (2009). Be(a)ware of spider! An Attentional Blink study on fear detection. *Archives Italiennes de Biologie*, 147, 95-103.

Dalgleish, T., Taghavi, R., Neshat-Doost, H., Moradi, A., Canterbury, R., & Yule, W. (2003). Patterns of processing bias for emotional information across clinical disorders: A comparison of attention, memory, and prospective cognition in children and adolescents with depression, generalized anxiety, and posttraumatic stress disorder. *Journal of Clinical Child and Adolescent Psychology*, 32(1), 10-21.

Dandeneau, S. D., Baldwin, M. W., Baccus, J. R., Sakellaropoulo, M., & Pruessner, J. C. (2007). Cutting stress off at the pass: Reducing vigilance and responsiveness to social threat by manipulating attention. *Journal of Personality and Social Psychology*, 93(4), 651-66.

Darwin, C. R. (1872). *The origin of species by means of natural selection, or the preservation of favoured races in the struggle for life* (6th ed.). London, UK: John Murray.

Davis, M., & Whalen, P. J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry*, 6, 13-34.

de Jong, P. J., Koster, E. H. W, van Wees, R., & Martens, S. (2009). Emotional facial expressions and the attentional blink: Attenuated blink for angry and happy faces irrespective of social anxiety. *Cognition and Emotion*, 23(8), 1640-1652.

de Jong, P. J., & Martens, S. (2007). Detection of emotional expressions in rapidly changing facial displays in high- and low-socially anxious children. *Behaviour Research and Therapy*, 45, 1285-1294.

Derakshan, N., Smyth, S., & Eysenck, M. W. (2009). Effects of state anxiety on performance using a task-switching paradigm: An investigation of attentional control theory. *Psychonomic Bulletin & Review*, 16(6), 1112-1117.

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology*, 111, 225-236.

Derryberry, D., & Rothbart, M. K. (1988). Arousal, affect, and attention as components of temperament. *Journal of Personality and Social Psychology*, 55, 958-966.

de Ruiter, C., & Brosschot, J. F. (1994). The emotional Stroop interference effect in anxiety: Attentional bias or cognitive avoidance? *Behaviour Research and Therapy*, 32, 315-319.

Di Lollo, V., Kawahara, J., Ghorashi, S. M. S., & Enns, J. T. (2005). The attentional blink: Resource depletion or temporary loss of control? *Psychological Research*, 69(3), 191-200.

Dimberg, U. (1997). Social fear and expressive reactions to social stimuli. *Scandinavian Journal of Psychology*, 38(3), 171-174.

Dimberg, U., & Christmanson, L. (1997). Facial reactions to facial expressions in subjects high and low in public speaking fear. *Scandinavian Journal of Psychology*, 32, 246-253.

Dimberg, U., & Thunberg, M. (2007). Speech anxiety and rapid emotional reactions to angry and happy facial expressions. *Scandinavian Journal of Psychology*, 48, 321-328.

Donnelly, N., Cave, K., Greenway, R., Hadwin, J. A., Stevenson, J., & Sonuga-Barke, E. (2007). Visual search in children and adults: Top-down and bottom-up mechanisms. *Quarterly Journal of Experimental Psychology*, 60(1), 120-136.

Donnelly, N., Hadwin, J. A., Menneer, T., & Richards, H. J. (2010). The use of visual search paradigms to understand attentional biases in childhood anxiety. In J. A. Hadwin & A. P. Field (Eds.), *Information processing biases and anxiety. A developmental perspective* (pp. 129-149). Chichester, UK: Wiley-Blackwell.

Driver, J. (2001). A selective review of selective attention research from the past century. *British Journal of Psychology*, 92, 53-78.

Dubner, A. E., & Motta, R. W. (1999). Sexually and physically abused foster care children and posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology*, 67(3), 367-373.

Dux, P. E., & Marois, R. (2009). The attentional blink: A review of data and theory. *Attention, Perception, & Psychophysics*, 71(8), 1683-1700.

Eastwood, J. D., Smilek, D., Oakman, J. M., Farvolden, P. Van Ameringen, M., Mancini, C., & Merikle, P. M. (2005). Individuals with social phobia are biased to become aware of negative faces. *Visual Cognition*, 12, 159-179.

Egger, H. L., & Angold, A. (2006). Common and emotional behavioural disorders in preschool children: Presentation, nosology and epidemiology. *Journal of Child Psychology and Psychiatry*, 47, 313-337.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, 6, 169-200.

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion*. Chichester, UK: Wiley.

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behaviour: Categories, origins, usage, and coding. *Semiotica*, 1, 49-98.

Elam, K. K. (2010). Emotional faces capture spatial attention in 5-year-old children. *Evolutionary Psychology*, 8(4), 754-767.

Eldar S., Apter A., Lotan D., Edgar K. P., Naim R., Fox N. A., Pine D. S., & Bar-Haim Y. (2012). Attention bias modification treatment for pediatric anxiety disorders: A randomized controlled trial. *The American Journal of Psychiatry*, 169(2), 213-220.

Essau, C.A., Conradt, J., & Petermann, F. (2002). Course and outcome of anxiety disorders in adolescents. *Anxiety Disorders*, 16, 67-81.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, 7(2), 336-353.

Eysenck, M. W., & Keane, M. T. (2005). *Cognitive psychology* (5th ed.). Hove, UK: Psychology Press.

Eysenck, M. W., Mogg, K., May, J., Richards, A., & Mathews, A. (1991). Bias in interpretation of ambiguous sentences related to threat in anxiety. *Journal of Abnormal Psychology*, 100, 144-150.

Facoetti, A., Ruffino, M., Peru, A., Paganoni, P., & Chelazzi, L. (2008). Sluggish engagement and disengagement of non-spatial attention in dyslexic children. *Cortex*, 44, 1221-1233.

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience*, 14, 340-347.

Fernandez-Duque, D., & Posner, M. I. (1997). Relating the mechanisms of orienting and alerting. *Neuropsychologia*, 35, 477-486.

Field, A. P. (2006). Watch out for the beast: Fear information and attentional bias in children. *Journal of Clinical Child and Adolescent Psychology*, 35(3), 431-439.

Field, A. P., & Lawson, J. (2003). Fear information and the development of fears during childhood: Effects on implicit fear responses and behavioural avoidance. *Behaviour Research and Therapy*, 41, 1277-1293.

Field, A. P., & Lester, K. J. (2010). Is there room for 'development' in developmental models of information processing biases to threat in children and adolescents? *Clinical Child and Family Psychology Review*, 13, 315-332.

Fossati, P. (2012). Neural correlates of emotion processing: From emotional to social brain. *European Neuropsychopharmacology*, 22(3), 487-491.

Fox, E. (2008). *Emotion science: Cognitive and neuroscientific approaches to understanding human emotions*. Basingstoke, UK: Palgrave Macmillan.

Fox, E., Lester, V., Russo, R., Bowles, R. J., Pichler, A., & Dutton, K. (2000). Facial expressions of emotion: Are angry faces detected more efficiently? *Cognition and Emotion*, 14(1), 61-92.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General*, 130, 681-700.

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: evidence for delayed disengagement from emotional faces. *Cognition and Emotion*, 16, 355.

Fox, E., Russo, R., & Georgiou, G. A. (2005). Anxiety modulates the degree of attentive resources required to process emotional faces. *Cognitive, Affective & Behavioural Neuroscience*, 5(4), 396-404.

Freeman, J. B., & Beck, J. G. (2000). Cognitive interference for trauma cues in sexually abused adolescent girls with posttraumatic stress disorder. *Journal of Clinical Child Psychology*, 29, 245-256.

Frewen, P. A., Dozois, D. J. A., Joanisse, M. F., & Neufeld, R. W. J. (2008). Selective attention to threat versus reward: Meta-analysis and neural-network modelling of the dot-probe task. *Clinical Psychology Review*, 28, 307-337.

Gamble, A. L., & Rapee, R. M. (2009). The time-course of attentional bias in anxious children and adolescents. *Journal of Anxiety Disorders*, 23(7), 841-847.

Garner, M. (2010). Selective attention to threat in childhood anxiety: Evidence from visual probe investigations. In J. A. Hadwin & A. P. Field (Eds.), *Information processing biases and anxiety: A developmental perspective* (pp. 129-149). Chichester, UK: Wiley-Blackwell.

Garner, M., Mogg, K., & Bradley, B. P. (2006). Orienting and maintenance of gaze to facial expressions in social anxiety. *Journal of Abnormal Psychology*, 115, 760-770.

Garrad-Cole, F., Shapiro, K. L., & Thierry, G. (2011). Developmental aspects of temporal and spatial visual attention: Insights from the attentional blink and visual search tasks. *Child Neuropsychology*, 17(2), 118-137.

Gerhardstein, P., & Rovee-Collier, C. (2002). The development of visual search in infants and very young children. *Journal of Experimental Child Psychology*, 81, 194-215.

Giannakopoulos, G., Kazantzi, M., Dimitrakaki, C., Tsiantis, J., Kolaitis, G., & Tountas, Y. (2009). Screening for children's depression symptoms in Greece: The use of the Children's Depression Inventory in a nation-wide school-based sample. *European Child and Adolescent Psychiatry*, 18(8), 485-492.

Gilboa-Schechtman, E., Foa, E. B., & Amir, N. (1999). Attentional bias for facial expressions in social phobia: The face-in-the-crowd paradigm. *Cognition and Emotion*, 13, 305-318.

Goffman, E. (1967). *Interaction ritual: Essays on face-to-face behaviour*. New York, USA: Anchor Books.

Goodman, G.S. (1984). Children's testimony in historical perspective. *Journal of Social Issues*, 40, 9-32.

Gould, D., Kelly, D., Goldstone, L., & Gammon, J. (2001). Examining the validity of pressure ulcer risk assessment scales: Developing and using illustrated patient simulations to collect the data. *Journal of Clinical Nursing*, 10, 697-706.

Gray, K. L. H., Adams, W. J., & Garner, M. (2009). The influence of anxiety on the initial selection of emotional faces presented in binocular rivalry. *Cognition*, 113, 105-110.

Green, H., McGinnity, A., Meltzer, H., Ford, T., & Goodman, R. (2005). *Mental health of children and young people in Great Britain, 2004*. London: Palgrave Macmillan.

Hadwin, J. A., Donnelly, N., Richards, A., French, C. C., & Patel, U. (2009). Childhood anxiety and attention to emotion faces in a modified Stroop task. *British Journal of Developmental Psychology*, 27, 487-494.

Hadwin, J. A., & Field, A. P. (2010). *Information processing biases and anxiety: A developmental perspective*. Chichester, UK: Wiley-Blackwell.

Hadwin, J., Frost, S., French, C. C., & Richards, A. (1997). Cognitive processing and trait anxiety in typically developing children: Evidence for interpretation bias. *Journal of Abnormal Psychology, 106*, 486-490.

Kakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N. A., Leibenluft, E., Ernst, M., & Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry, 68*, 982-990.

Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology, 54*, 917-924.

Hayes, M. H. S., & D. G. Patterson (1921). Experimental development of the graphic rating method. *Psychological Bulletin, 18*, 98-99.

Hayward, C., Killen, J. D., Kraemer, H. C., & Taylor, C. B. (2000). Predictors of panic attacks in adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 39*(2), 207-214.

Heim, S., Wirth, N., & Keil, A. (2011). Competition for cognitive resources during rapid serial processing: Changes across childhood. *Frontiers in Psychology, 2*(9).

Heim-Dreger, U., Kohlmann, C. W., Eschenbeck, H., & Burkhardt, U. (2006). Attentional biases for threatening faces in children: Vigilant and avoidant processes. *Emotion, 6*(2), 320-325.

Hess, U., Adams, R. B. Jr., & Kleck, R. E. (2005). Who may frown and who should smile? Dominance, affiliation, and the display of happiness and anger. *Cognition and Emotion, 19*, 515-536.

Hess, U., Blairy, S., & Kleck, R. E. (2000). The influence of expression intensity, gender, and ethnicity on judgments of dominance and affiliation. *Journal of Nonverbal Behaviour, 24*, 265-283.

Heuer, K., Rinck, M., & Becker, E. S. (2007). Avoidance of emotional facial expressions in social anxiety: The Approach-Avoidance Task. *Behaviour Research and Therapy*, 45(12), 2990-3001.

Hirsch, C., Clark, D. M., & Mathews, A. (2006). Interpretative influences when reading about emotional events. *Behaviour Research Therapy*, 32(12), 1123-1132.

Hirschfeld, R. M. A. (2001). The comorbidity of major depression and anxiety disorders: Recognition and management in primary care. *Primary Care Companion to the Journal of Clinical Psychiatry*, 3(6), 244-254.

Hommel, B., & Akyürek, E. G. (2005). Lag-1 sparing in the attentional blink: Benefits and costs of integrating two events into a single episode. *Quarterly Journal of Experimental Psychology*, 58A, 1415-1433.

Horley, K., Williams, L. M., Gonsalvez, C., & Gordon, E. (2004). Face to face: Visual scanpath evidence for abnormal processing of facial expressions in social phobia. *Psychiatry Research*, 127, 43-53.

Huang, Y. M., Baddeley, A., & Young, A. W. (2008). Attentional capture by emotional stimuli is modulated by semantic processing. *Journal of Experimental Psychology: Human Perception and Performance*, 34(2), 328-339.

Hudson, J. L., & Rapee, R. M. (2004). From anxious temperament to disorder: An etiological model of generalised anxiety disorder. In R. G. Heimberg, C. L. Turk, & D. S. Mennin (Eds.), *Generalised anxiety disorder: Advances in research and practice* (pp. 51-74). New York, USA: Guilford Press.

Hunt, C., Keogh, E., & French, C. C. (2007). Anxiety sensitivity, conscious awareness and selective attentional biases in children. *Behaviour Research and Therapy*, 45(3), 497-509.

In-Albon, T., Kossowsky, J., & Schneider, S. (2010). Vigilance and avoidance of threat in the eye movements of children with separation anxiety disorder. *Journal of Abnormal Psychology* 38(2), 225-235.

In-Albon, T., & Schneider, S. (2010). Using eye-tracking methodology in children with anxiety disorders. In J. A. Hadwin & A. P. Field (Eds.), *Information processing biases and anxiety: A developmental perspective* (pp. 129-149). Chichester, UK: Wiley-Blackwell.

Ioannou, M. C., Mogg, K., & Bradley, B. P. (2004). Vigilance for threat: Effects of anxiety and defensiveness. *Personality and Individual Differences*, 36(8), 1879-1891.

Jordan, A. D., Dolcos, S., & Dolcos, F. (2013). Neural signatures of the response to emotional distraction: A review of evidence from brain imaging investigations. *Frontiers in Human Neuroscience*, 7(200).

James, W. (1890). *The principles of psychology*. New York, USA: Holt.

Jefferies, L. N., Smilek, D., Eich, E., & Enns, J. T. (2008). Emotional valence and arousal interact in attentional control. *Psychological Science*, 19(30), 290-295.

Juth, P., Lundqvist, D., Karlsson, A., & Öhman, A. (2005). Looking for foes and friends: Perceptual and emotional factors when finding a face in the crowd. *Emotion*, 5, 379-395.

Kagan, J., Kearsley, R. B., & Zelazo, P. R. (1978). *Infancy: Its place in human development*. Cambridge, MA, USA: Harvard University Press.

Kail, R. (1991). Processing time declines exponentially during childhood and adolescence. *Developmental Psychology*, 27, 259-266.

Kallen, V. L., Ferdinand, R. F., & Tullen, J. H. (2007). Early attention processes and anxiety in children. *Perception Motor Skills*, 104(1), 221-235.

Kanwisher, N. (1987). Repetition blindness: Type recognition without token individuation.

Cognition, 27, 117-143.

Keil, A., & Ihssen, N. (2004). Identification facilitation for emotionally arousing verbs during the attentional blink. *Emotion*, 4(1), 23-35.

Kendall, P. C. (1985). Toward a cognitive-behavioural model of child psychopathology and a critique of related interventions. *Journal of Abnormal Child Psychology*, 13(3), 357-372.

Kessler, R. C., Berglund, P., Delmer, O., Jin, R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, 62, 593-602.

Kessler, R. C., Foster, C. L., Saunders, W. B., & Stang, P. E. (1995). Social consequences of psychiatric disorders: Educational attainment. *American Journal of Psychiatry*, 152(7), 1026-1032.

Kihara, K., & Osaka, N. (2008). Early mechanism of negativity bias: An attentional blink study. *Japanese Psychological Research*, 50(1), 1-11.

Kim-Cohen, J., Caspi, A., Moffitt, T. E., Harrington, H., Milne, B. J., & Poulton, R. (2003). Prior juvenile diagnoses in adults with mental disorder: Developmental follow-back of a prospective-longitudinal cohort. *Archives of General Psychiatry*, 60, 709-717.

Kindt, M., Bierman, D., & Brosschot, J. F. (1996). Stroop versus Stroop: Comparison of a card format and a single-trial format of the standard color-word Stroop task and the emotional Stroop task. *Personality and Individual Differences*, 21, 653-661.

Kindt, M., Bierman, D., & Brosschot, J. F. (1997). Cognitive bias in spider fear and control children: Assessment of emotional interference by a card format and a single-trial format of the Stroop task. *Journal of Experimental Child Psychology*, 66, 163-179.

Kindt, M., Bögels, S., & Morren, M. (2003). Processing bias in children with separation anxiety disorder, social phobia and generalised anxiety disorder. *Behaviour Change*, 20, 143-150.

Kindt, M., & Brosschot, J. F. (1999). Cognitive bias in spider-phobic children: Comparison of a pictorial and a linguistic spider Stroop. *Journal of Psychopathology and Behavioral Assessment*, 21(3), 207-220.

Kindt, M., Brosschot, J. F., & Everaerd, W. (1997). Cognitive processing bias of children in a real life stress situation and a neutral situation. *Journal of Experimental Child Psychology*, 64, 79-97.

Kindt, M., & van den Hout, M. (2001). Selective attention and anxiety: A perspective on developmental issues and causal status. *Journal of Psychopathology and Behavioural Assessment*, 23, 193-201.

Kindt, M., van den Hout, M., de Jong, P., & Hoekzema, B. (2000). Cognitive bias for pictorial and linguistic threat cues in children. *Journal of Psychopathology and Behavioural Assessment*, 22(2), 201-219.

Kirisci, L. & Clark, B. D. (1996, April). *Reliability and validity of the State-Trait Anxiety Inventory for Children in an adolescent sample: Confirmatory factor analysis and item response theory*. Paper presented at the annual meeting of the American Educational Research Association, New York, USA.

Klein, A. M., Becker, E. S., & Rinck, M. (2011). Approach and avoidance tendencies in spider fearful children: The Approach-Avoidance Task. *Journal of Child and Family Studies*, 20(2), 224-231.

Kolassa, I. T., Kolassa, S., Bergmann, S., Lauche, R., Dilger, S., Miltner, W. H. R., & Musial, F. (2009). Interpretive bias in social phobia: An ERP study with morphed emotional schematic faces. *Cognition and Emotion*, 23(1), 69-95.

Koster, E. H. W., Crombez, G., Van Damme, S., Verschuere, B., & De Houwer, J. (2004). Does imminent threat capture and hold attention? *Emotion*, 4(3), 312-317.

Koster, E. H. W., Crombez, G., Van Damme, S., Verschuere, B., & De Houwer, J. (2005). Signals for threat modulate attentional capture and holding: Fear-conditioning and extinction during the exogenous cueing task. *Cognition and Emotion*, 19, 771-780.

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy*, 42, 1183-1192.

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2006). Attention to threat in anxiety-prone individuals: Mechanisms underlying attentional bias. *Cognitive Therapy and Research*, 30, 635-643.

Koster, E. H. W., Crombez, G., Verschuere, B., Van Damme, S., & Wiersema, J. R. (2006). Components of attentional bias to threat in high trait anxiety: Facilitated engagement, impaired disengagement, and attentional avoidance. *Behaviour Research and Therapy*, 44, 1757-1771.

Koster, E. H. W., Verschuere, B., Crombez, G., & Van Damme, S. (2005). Time-course of attention for threatening pictures in high and low trait anxiety. *Behaviour Research and Therapy*, 43, 1087-1098.

Kovacs, M. (1981). Rating scales to assess depression in school aged children. *Acta Paedopsychiatrica*, 46(5-6), 305-315.

Kovacs, M. (1985). The Children's Depression Inventory (CDI). *Psychopharmacology Bulletin*, 21(4), 995-998.

Kovacs, M. (1992). *Children's Depression Inventory Manual*. Los Angeles, USA: Western Psychological Services.

Kovacs, M. (2003). *Children's Depression Inventory: Technical Manual Update*. Toronto: Multi-Health Systems.

Kovacs, I., Papathomas, T. V., Yang, M., & Feher, A., (1996). When the brain changes its mind: Interocular grouping during binocular rivalry. *Proceedings of the National Academy of Sciences of the United States of America*, 93, 15508-15511.

Kowler, E., Anderson, E., Doshier, B., & Blaser, E. (1995). The role of attention in the programming of saccades. *Vision Research*, 13, 1897-1916.

Kranczioch, C., Debener, S., Schwarzbach, J., Goebel, R., & Engel, A. K. (2005). Neural correlates of conscious perception in the attentional blink. *Neuroimage*, 24, 704-714.

Krieglmeyer, R., & Deutsch, R. (2013). Approach does not equal approach: Angry facial expressions evoke approach only when it serves aggression. *Social Psychological and Personality Science*, 00(0), 1-8.

Lader, M., & Marks, I. (1973). *Clinical anxiety*. London, UK: Heinemann.

Lahar, C. J., Isaak, M. I., & McArthur, A. D. (2001). Age differences in the magnitude of the attentional blink. *Aging Neuropsychology and Cognition*, 8(2), 149-159.

Lallier, M., Donnadieu, S., & Valdois, S. (2010). Visual attentional blink in dyslexic children: Parameterizing the deficit. *Vision Research*, 50, 1855-1861.

Lang P. J., Bradley M. M., & Cuthbert B. N. (1999). *International Affective Picture System (IAPS): Technical manual and affective ratings*. University of Florida, Gainesville, FL.

Lang P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioural reactions. *Psychophysiology*, 30(3), 261-273.

Lange, W. G., Keijsers, G. Rinck, M., & Becker, E. (2008). Social anxiety and evaluation of social crowds: Explicit and implicit measures. *Behaviour Research and Therapy*, 46, 932-943.

Lange, W. G., Salemink, E., Windey, I., Keijsers, G. P. J., Krans, J., Becker, E. S., & Rinck, M. (2010). Does modified interpretation bias influence automatic avoidance behavior? *Applied Cognitive Psychology*, 24, 326–337.

La Rocque, C. L. L., & Visser, T. A. W. (2009). Sequential object recognition deficits in normal readers. *Vision Research*, 49, 96-101.

Lawrence, D. H. (1971). Two studies of visual search for word targets with controlled rates of presentation. *Perception & Psychophysics*, 35, 558-564.

LeDoux, J. E. (1996). The emotional brain. New York, USA: Simon & Schuster.

Lee, E., Kang, J. I., Park, I. H., Kim, J. J., & An, S. K. (2008). Is a neutral face really evaluated as being emotionally neutral? *Psychiatry Research*, 157(1-3), 77-85.

Legerstee, J. S., Tulen, J. H. M., Kallen, V. L., Dielam, G. C., Treffers, P. D. A., Verhulst, F. C., & Utens, E. M. W. J. (2009). Threat-related selective attention predicts treatment success in childhood anxiety disorders. *Journal of the American Academy of Child and Adolescent Psychiatry*, 48(2), 196-205.

Lewinsohn, P. M., Holm-Denoma, J. M., Small, J. W., Seeley, J. R., & Joiner, T. E. (2008). Separation anxiety disorder in childhood as a risk factor for future mental illness. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47, 548-555.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 140, 1-55.

Lipp, O. V., & Waters, A. M. (2007). When danger lurks in the background: Attentional capture by animal fear-relevant distracters is specific and selectively enhanced by animal fear. *Emotion*, 7, 192-200.

LoBue, V. (2009). More than just another face in the crowd: Superior detection of threatening facial expressions in children and adults. *Developmental Science*, 12(2), 305-313.

Logan, A. C., & Goetsch, V. L. (1993). Attention to external threat cues in anxiety states. *Clinical Psychology Review*, 13(6), 541-559.

Logothetis, N. K., Leopold, D. A., & Sheinberg, D. L. (1996). What is rivalling during binocular rivalry? *Nature*, 380, 621-624.

Lu, S., Cai, Y., Shen, M., Zhou, Y., & Han, S. (2012). Alerting and orienting of attention without visual awareness. *Consciousness and Cognition*, 21, 928-938.

Lumm, J. A. G., Conti-Ramsden, G., & Lindell, A. K. (2006). The attentional blink reveals sluggish attentional shifting in adolescents with specific language impairment. *Brain and Cognition*, 63, 287-295.

Luo, W. B., Feng, W. F., He, W. Q., Wang, N. Y., & Luo, Y. J. C. A. (2010). Three stages of facial expression processing: ERP study with rapid serial visual presentation. *Neuroimage*, 49(2): 1857-1867.

Lystad, C. M., Rokke, P. D., & Stout, D. M. (2009). Emotion congruent facilitation of attention when processing anxious stimuli. *Cognitive Therapy Research*, 33, 499-510.

Mack, A., Pappas, Z., Silverman, M., & Gay, R. (2002). What we see: Inattention and the capture of attention by meaning. *Consciousness and Cognition*, 11, 488-506.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, 109, 163-203.

MacLeod, C. M., & Bridle, R. (2006). *The modification of anxiety through the manipulation of attentional bias: Evaluation of a 16 day online attentional training program*. Paper presented at the convention of the European Association of Behavioural and Cognitive Therapies.

MacLeod, C. M., & Cohen, I. L. (1993). Anxiety and the interpretation of ambiguity: A text comprehension study. *Journal of Abnormal Psychology, 102*, 238-247.

MacLeod, C. M., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology, 40*, 653-670.

MacLeod, C. M., & Mathews, A. (2012). Cognitive bias modification approaches to anxiety. *Annual Review of Clinical Psychology, 8*, 189-217.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*, 15-20.

Maki, W. S., Bussard, G., Lopez, K., & Digby, B. (2003). Sources of interference in the attentional blink: Target-distractor similarity revisited. *Perception and Psychophysics, 65*(2), 188-201.

Mamassian, P., & Goutcher, R. (2005). Temporal dynamics in bi-stable perception. *Journal of Vision, 5*, 361-375.

Mansell W, Clark D. M., Ehlers A., & Chen Y. P. (1999). Social anxiety and attention away from emotional faces. *Cognition and Emotion, 13*(6).

Maratos, F. A. (2011). Temporal processing of emotional stimuli: The capture and release of attention by angry faces. *Emotion, 11*(5), 1242-1257.

Maratos, F. A., Mogg, K., & Bradley, B. P. (2008). Identification of angry faces in the attentional blink. *Cognition and Emotion, 00*(00), 1-13.

Marois, R., Chun, M. M., & Gore, J. C. (2000). Neural correlates of the attentional blink. *Neuron*, 28, 299-308.

Marsh, A. A., Adams, R. B., Jr., & Kleck, R. E. (2005). Why do fear and anger look the way they do? Form and social function in facial expressions. *Personality and Social Psychological Bulletin*, 31, 73-86.

Martin, J. M., & Cole, D. A. (2000). Using the personal Stroop to detect children's awareness of social rejection by peers. *Cognition and Emotion*, 14(2), 241-260.

Martin, M., Horder, P., & Jones, G. V. (1992). Integral bias in naming of phobia-related words. *Cognition and Emotion*, 6, 470-486.

Mason, D. J., Humphreys, G. W., & Kent, L. (2005). Insights into the control of attentional set in ADHD using the attentional blink paradigm. *Journal of Child Psychology and Psychiatry*, 46(12), 1345-1353.

Mathews, A. (1990). Why worry? The cognitive function of anxiety. *Behaviour Research and Therapy*, 28, 455-468.

Mathews, A., & Mackintosh, B. (1998). A cognitive model of selective processing in anxiety. *Cognitive Therapy and Research*, 22, 539-560.

Mathews, A., & Mackintosh, B. (2000). Induced emotional interpretation bias and anxiety. *Journal of Abnormal Psychology*, 109(4), 602-615.

Mathews, A., Mackintosh, B., & Fulcher, E. P. (1997). Cognitive biases in anxiety and attention to threat. *Trends in Cognitive Sciences*, 1, 340-345.

Mathews, A., & MacLeod, C. (1986). Discrimination of threat cues without awareness in anxiety-states. *Journal of Abnormal Psychology*, 95(2), 131-138.

Mathewson, K. J., Arnell, K. M., & Mansfield, C. A. (2008). Capturing and holding attention: The impact of emotional words in rapid serial visual presentation. *Memory and Cognition*, 35(1), 182-200.

McClure, E. B., Monk, C. S., Nelson, E. E., Parrish, J. M., Adler, A., Blair, R. J., Fromm, S., Charney, D. S., Leibenluft, E., Ernst, M., & Pine, D. S. (2007). Abnormal attention modulation of fear circuit function in paediatric generalised anxiety disorder. *Archives of General Psychiatry*, 64, 109-116.

McGee, R., Feehan, M., Williams, S., & Anderson, J. (1992). DSM-III disorders from age 11 to age 15 years. *Journal of American Academy of Child and Adolescent Psychiatry*, 31(1), 50-59.

McLean, G. M. T., Castles, A., Coltheart, V., & Stuart, G. W. (2010). No evidence for a prolonged attentional blink in developmental dyslexia. *Cortex*, 46, 1317-1329.

McLean, G. M. T., Stuart, G. W., Visser, T. A. W., & Castles, A. (2009). The attentional blink in developing readers. *Scientific Studies of Reading*, 13(4), 334-357.

McManus, S., Meltzer, H., Brugha, T., Bebbington, P., & Jenkins, R. (Eds.) (2009). *Adult psychiatric morbidity in England, 2007: Results of a household survey*. London, UK: The NHS Information Centre for Health and Social Care.

Merikangas, K. R., Avenevoli, S., Dierker, L., & Grillon, C. (1999). Vulnerability factors among children at risk for anxiety disorders. *Biological Psychiatry*, 46, 1523-1535.

Meyer, J., & Jesilow, P. (1997). Obedience to authority: Possible effects on children's testimony. *Psychology, Crime and Law*, 3(2), 81-95.

Milders, M., Sahraie, A., Logan, S., & Donnellon, N. (2006). Awareness of faces is modulated by their emotional meaning. *Emotion*, 6(1), 10-17.

Milgram, S. (1974). *Obedience to authority: An experimental view*. New York, USA: Harper and Row.

Miltner, W. H. R., Krieschel, S., Hecht, H., Trippe, R., & Weiss, T. (2004). Eye movements and behavioural responses to threatening and nonthreatening stimuli during visual search in phobic and nonphobic subjects. *Emotion*, 4, 323-339.

Mineka, S., Watson, D. W., & Clark, L. A. (1998). Psychopathology: Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology*, 49, 377-412.

Miyazawa, S., & Iwasaki, S. (2010). Do happy faces capture attention? The happiness superiority effect in attentional blink. *Emotion*, 10(5), 712-716.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, 36, 809-848.

Mogg, K., & Bradley, B. P. (1999). Orienting of attention to threatening facial expressions presented under conditions of restricted awareness. *Cognition and Emotion*, 13(6), 713-740.

Mogg, K., & Bradley, B. P. (2005). Attentional bias in generalised anxiety disorder versus depressive disorder. *Cognitive Therapy and Research*, 29(1), 29-45.

Mogg, K., Bradley, B. P., de Bono, J. D., & Painter, M. (1998). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy*, 35, 297-303.

Mogg, K., & Bradley, B. P., Miles, F., & Dixon, C. (2004). Time course of attentional bias for threat scenes: Testing the vigilance-avoidance hypothesis. *Cognition and Emotion*, 18, 689-700.

Mogg, K., Garner, M., & Bradley, B. P. (2007). Anxiety and orienting of gaze to angry and fearful faces. *Biological Psychology*, 76, 163-169.

Mogg, K., Mathews, A. & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology*, 96, 94-98.

Mogg, K., Millar, N., & Bradley, B. P. (2000). Biases in eye movements to threatening facial expressions in generalised anxiety disorder and depressive disorder. *Journal of Abnormal Psychology*, 109(4), 695-704.

Mogg, K., Phillipott, P., & Bradley, B. P. (2004). Selective attention to angry faces in clinical social phobia. *Journal of Abnormal Psychology*, 113(1), 160-165.

Monk, C. S., Nelson, E. E., McClure, E. B., Mogg, K., Bradley, B. P., Leibenluft, E., Blair, R. J., Chen, G., Charney, D. S., Ernst, M., & Pine, D. S. (2006). Ventrolateral prefrontal cortex activation and attention bias in response to angry faces in adolescents with generalised anxiety disorder. *American Journal of Psychiatry*, 163, 1091-1097.

Monk, C. S., Telzer, E. H., Mogg, K., Bradley, B. P., Mai, X. Q., Louro, H. M. C., Chen, G., McClure-Tone, E. B., Ernst, M., & Pine, D. S. (2008). Amygdala and ventrolateral prefrontal cortex activation to masked angry faces in children and adolescents with generalised anxiety disorder. *Archives of General Psychiatry*, 65(5), 568-576.

Mohlman, J. (2004). Attention training as an intervention for anxiety: Review and rationale. *Behavior Therapist*, 27, 37-41.

Moradi, A. R., Neshat-Doost, H. T., Taghavi, R., Yule, W., & Dalgleish, T. (1999). Performance of children of adults with PTSD on the Stroop colour-naming task. *Journal of Traumatic Stress*, 12 (4), 663-672.

Moradi A. R., Taghavi M. R., Neshat-Doost H. T., Yule W., & Dalgleish T. (1999). Performance of children and adolescents with PTSD on the Stroop colour-naming task. *Psychological Medicine*, 29, 415-419.

Morren, M., Kindt, M., van den Hout, M., & van Kasteren, H. (2003). Anxiety and the processing of threat in children: Further examination of the cognitive inhibition hypothesis. *Behaviour Change*, 20(3), 131-142.

Most, S. B., Chun, M. M., Widders, D. M., & Zald, D. H. (2005). Attentional rubbernecking: Cognitive control and personality in emotion-induced blindness. *Psychonomic Bulletin & Review*, 12(2), 654-661.

Muris, P. (2007). *Normal and abnormal fear and anxiety in children and adolescents*. Burlington, UK: Elsevier Science.

Muris, P., de Jong, P. J., & Engelen, S. (2004). Relationships between neuroticism, attentional control, and anxiety disorders symptoms in non-clinical children. *Personality and Individual Differences*, 37, 789-797.

Muris, P., & Field, A. P. (2008). Distorted cognition and pathological anxiety in children and adolescents. *Cognition and Emotion*, 22(3), 395-421.

Muris, P., & Merckelbach, H. (2001). The etiology of childhood specific phobia: a multifactorial model. In M. Vasey & M. R. Dadds (Eds.), *The developmental psychopathology of anxiety* (pp. 355-385). Oxford, UK: Oxford University Press.

Muris, P., Merckelbach, H., Gadet, B., & Moulaert, V. (2000). Fears, worries, and scary dreams in 4-12 year old children: Their content, developmental pattern, and origins. *Journal of Clinical Child Psychology*, 29, 43-52.

Newmark, C., Frerking, R., Cook, L. K., & Newmark, L. (1973). Endorsement of Ellis' irrational beliefs as a function of psychopathology. *Journal of Clinical Psychology*, 29, 300-302.

Nieuwenstein, M. R. (2006). Top-down controlled, delayed selection in the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance*, 32, 973-985.

Ogawa, T., & Suzuki, N. (2004). On the saliency of negative stimuli: Evidence from attentional blink. *Japanese Psychological Research*, 46(1), 20-30.

Öhman, A. (1993). Fear and anxiety as emotional phenomena: Clinical phenomenology, evolutionary perspectives, and information processing mechanisms. In M. Lewis & J. M. Haviland (Eds.). *Handbook of emotions*. New York, USA: Guilford.

Öhman, A. (1996). Preferential preattentive processing of threat in anxiety: Preparedness and attentional biases. In R. M. Rapee (Ed.), *Current controversies in the anxiety disorders*. New York, USA: Guilford Press.

Öhman, A. (2005). The role of the amygdala in human fear: Automatic detection of threat. *Psychoneuroendocrinology*, 30, 953-958.

Öhman, A., & Birbaumer, N. (1993). *The structure of emotion: Psychophysiological, cognitive and clinical aspects*. Seattle, WA, USA: Hogrefe and Huber.

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, 130, 466-478.

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology*, 80(3), 381-396.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review*, 108, 483-522.

Öhman, A., & Mineka, S. (2003). The malicious serpent: Snakes as a prototypical stimulus for an evolved module of fear. *Current Directions in Psychological Science*, 12(1), 5-9.

Olivers, C. N. L., & Meeter, M. (2008). A boost and bounce theory of temporal attention. *Psychological Review*, 115(4), 836-863.

Ouimet, A. J., Gawronski, B., & Dozois, D. J. A. (2009). Cognitive vulnerability to anxiety: A review and an integrative model. *Clinical Psychology Review*, 29(6), 459-470.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. New York, USA: Oxford University Press.

Papay, J., & Spielberger, C. D. (1986). Assessment of anxiety and achievement in kindergarten and first- and second-grade children. *Journal of Abnormal Child Psychology*, 14, 279-286.

Peers, P. V., & Lawrence, A. D. (2009). Attentional control of emotional distraction in rapid serial visual presentation. *Emotion*, 9, 140-145.

Pérez-Edgar, K., & Bar-Haim, Y. (2010). Application of cognitive neuroscience techniques to the study of anxiety-related processing biases in children. In J. A. Hadwin, & A. P. Field (Eds.), *Information processing biases and anxiety: A developmental perspective*. Chichester, UK: Wiley-Blackwell.

Perowne, S., & Mansell, W. (2002). Social anxiety, self-focused attention, and the discrimination of negative, neutral and positive audience members by their non-verbal behaviours. *Behavioural and Cognitive Psychotherapy*, 30, 11-23.

Pessoa, L. (2005). To what extent are emotional visual stimuli processed without attention and awareness? *Current Opinion in Neurobiology*, 15(2), 188-196.

Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: From a 'low road' to 'many roads' of evaluating biological significance. *Nature Reviews Neuroscience*, 11(11), 773-783.

Peterson, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years after. *The Annual Review of Neuroscience*, 35, 73-89.

Pine, D. S., Mogg, K., Bradley, B. P., Montgomery, L., Monk, C. S., McClure, E., Guyer, A. E., Ernst, M., Charney, D. S., & Kaufman, J. (2005). Attention bias to threat in maltreated children: implications for vulnerability to stress-related psychopathology. *American Journal of Psychiatry*, 162, 291-296.

Pishyar, R., Harris, L., & Menzies, R. (2004). Attentional bias for words and faces in social anxiety. *Anxiety Stress and Coping*, 17(1), 23-36.

Pishyar, R., Harris, L., & Menzies, R. (2008). Responsiveness of measures of attentional bias to clinical change in social phobia. *Cognition and Emotion*, 22(7), 1209-1227.

Pistoia F., Conson M., Trojano L., Grossi D., Ponari M., Colonnese C., Pistoia, M. L., Carducci, F., & Sarà, M. (2010). Impaired conscious recognition of negative facial expressions in patients with locked-in syndrome. *The Journal of Neuroscience*, 30, 7838–7844.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology*, 32, 3-25.

Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. In H. Bouma & D. Bouwhuis (Eds.), *Attention and performance* (pp. 531-556). Hove, UK: Erlbaum.

Posner, M. I., & Peterson, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience*, 13, 25-42.

Posner, M. I., Snyder, C. R. R., & Davidson, B. J. (1980). Attention and the detection of signals. *Journal of Experimental Psychology: General*, 109(2), 160-174.

Potter, M. C., & Levy, E. I. (1969). Recognition memory for a rapid sequence of pictures. *Journal of Experimental Psychology*, 81(1), 10-15.

Pourtois, G., Grandjean, D., Sander, D., & Vuilleumier, P. (2004). Electrophysiological correlates of rapid spatial orienting towards fearful faces. *Cerebral Cortex*, 14, 619-633.

Pflugshaupt, T., Mosimann, U. P., von Wartburg, R., Schmitt, W., Nyffeler, T., & Muri, R. M. (2005). Hypervigilance-avoidance pattern in spider phobia. *Journal of Anxiety Disorders*, 19, 105-116.

Rachman, S. (1981). Unwanted intrusive cognitions. *Advances in Behaviour Research and Therapy*, 3, 89-99.

Rakison, D. H., & Derringer, J. (2008). Do infants possess an evolved spider-detection mechanism? *Cognition*, 107, 381-393.

Rapee, R. M. (2001). The development of generalised anxiety disorder. In M. W. Vasey, & M. R. Dadds (Eds.), *The developmental psychopathology of anxiety* (pp. 481-503). New York, USA: Oxford University Press.

Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioural model of anxiety in social phobia. *Behaviour Research and Therapy*, 35, 741-756.

Ray Li, Lin, Chang, & Hung, (2004). A psychophysical measure of attention deficit in children with attention-deficit/hyperactivity disorder. *Journal of Abnormal Psychology*, 113(2), 228-236.

Raymond, J. E., Shapiro, K. L., & Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? *Journal of Experimental Psychology: Human Perception & Performance*, 18(3), 849-860.

Raz, A., & Buhle, J. (2006). Typologies of attentional networks. *Nature Reviews Neuroscience*, 7(5), 367-379.

Reeves, A., & Sperling, G. (1986). Attention gating in short-term visual memory. *Psychological Review*, 93(2), 180-206.

Reinecke, A., Rinck, M., & Becker, E. S. (2008). How preferential is the preferential encoding of threatening stimuli? Working memory biases in specific anxiety and the attentional blink. *Journal of Anxiety Disorders*, 22, 655-670.

Reynolds, W. M. (1994). Assessment of depression in children and adolescents by self-report questionnaires. In Reynolds, W. M., & Johnston, H. F., *Handbook of depression in children and adolescents* (pp. 209–234). New York, USA: Plenum Press.

Richards, J. E. (2003). Attention affects the recognition of briefly presented visual stimuli in infants: An ERP study. *Developmental Science*, 6, 312–328.

Richards, A., French, C. C., Nash, G., Hadwin, J. A., & Donnelly, N. (2007). A comparison of selective attention and facial processing biases in typically developing children who are high and low in self-reported trait anxiety. *Development and Psychopathology*, 19(2), 481-495.

Richards, A., Richards, L. C., & McGeeney, A. (2000). Anxiety-related Stroop interference in adolescents. *Journal of General Psychology*, 127, 327-333.

Richey, J. A., & Schmidt, N. B. (2006). *Attention retraining as a treatment for social anxiety disorder*. Paper presented at the conference of the Association for Behavioural and Cognitive Therapies, Chicago, IL, USA.

Ridderinkhof, K. R., & van der Stelt (2000). Attention and selection in the growing child: views derived from developmental psychophysiology. *Biological Psychology*, 54(1-3), 55-106.

Rinck, M., & Becker, E. S. (2006). Spider fearful individuals attend to threat, then quickly avoid it: Evidence from eye movements. *Journal of Abnormal Psychology*, 115, 231–238.

Rinck, M., Becker, E. S., Kellermann, J., & Roth, W. T. (2003). Selective attention in anxiety. Distraction and enhancement in visual search. *Depression and Anxiety*, 18, 198-28.

Rinck, M., Reinecke, A., Ellwart, T., Heuer, K., & Becker, E. S. (2005). Speeded detection and increased distraction in fear of spiders: Evidence from eye movements. *Journal of Abnormal Psychology, 114*, 235-248.

Rinehart, N., Tonge, B., Brereton, A., & Bradshaw, J. (2010). Attentional blink in young people with high-functioning autism and Asperger's disorder. *Autism, 14*(1), 47-66.

Rizzo, M., Akutso, H., & Dawson, J. (2001). Increased attentional blink after focal cerebral lesions. *Neurology, 57*(5), 795-800.

Roberts, N., Vargo, B., & Ferguson, H. B. (1989). Measurement of anxiety and depression in children and adolescents. *Psychiatric Clinics of North America, 12*, 837-860.

Roelofs, K., Putman, P., Schouten, S., Lange, W. G., Volman, I., & Rinck, M. (2010). Gaze direction differentially affects avoidance tendencies to happy and angry faces in socially anxious individuals. *Behaviour Research and Therapy, 48*, 290-294.

Rohner, J. C. (2002). The time-course of visual threat processing: High trait anxious individuals eventually avert their gaze from angry faces. *Cognition and Emotion, 16*, 837-844.

Roy, A. K., Vasa, R. A., Bruck, M., Mogg, K., Bradley, B. P., Sweeney, M., Bergman, L., McClure-Tone, E. B., & Pine, D. S. (2008). Attention bias toward threat in pediatric anxiety disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*(10), 1189-1196.

Roza, S.J., Holstra, M.B., van der Ende, J., & Verhukst, F.C. (2003). Stable prediction of mood and anxiety disorders based on behavioural and emotional problems in childhood: A 14-year follow up during childhood, adolescences, and young adulthood. *American Journal of Psychiatry, 160*, 2116-2121.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*, 1161-1178.

Salemink, E., van den Hout, M. A., & Kindt, M. (2007). Selective attention to threat: Quick orienting versus slow disengagement and two versions of the dot probe task. *Behaviour Research and Therapy*, 45, 607-615.

Santesso, D. L., Meuret, A. E., Hofmann, S. G., Mueller, E. M., Ratner, K. G., Roesch, E. B., & Pizzagalli, D. A. (2008). Electrophysiological correlates of spatial orienting towards angry faces: a source localisation study. *Neuropsychologica*, 46, 1338-1348.

Saranson, S. B., Davidson, K. S., Lighthall, F. F., Waite, R. R., & Ruebush, B. K. (1960). *Anxiety in elementary school children*. New York: Wiley.

Schaefer, B. A., Watkins, M. W., & Burnham, J. J. (2003). Empirical fear profiles among American youth. *Behaviour Research and Therapy*, 41, 1093-1103.

Schechner, T., Jarcho, J. M., Britton, J. C., Leibenluft, E., Pine, D. S., & Nelson, E. E. (2013). Attention bias of anxious youth during extended exposure of emotional face pairs: An eye-tracking study. *Depression and Anxiety*, 30, 14-21.

Shapiro, K. L., Arnell, K. M., & Raymond, J. E. (1997). The attentional blink. *Trends in Cognitive Sciences*, 1, 291-296.

Shapiro, K. L., Caldwell, J., & Sorensen, R. E. (1997). Personal names and the attentional blink: A visual “cocktail party” effect. *Journal of Experimental Psychology: Human Perception and Performance*, 23(2), 504-514.

Shapiro, K. L., Raymond, J. E., & Arnell, K. M. (1994). Attention to visual pattern information produces the attentional blink in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, 20, 357-371.

Schmidt, N. B., Richey, A. J., Buckner, J. D., & Timpano, K. R. (2009). Attention training for generalised social anxiety disorder. *Journal of Abnormal Psychology*, 118(1), 5-14.

Schneider, S., Unnewehr, S., In-Albon, T., & Margraf, J. (2008). Attention bias in children of patients with panic disorder. *Psychopathology*, 41(3), 179-186.

Schultheiss, O. C., & Hale, J. A. (2007). Implicit motives modulate attentional orienting to perceived facial expressions of emotion. *Motivation and Emotion*, 31(1), 13-24.

Schultheiss, O. C., Pang, J. S., Torges, C. M., Wirth, M. M., & Treynor, W. (2005). Perceived facial expressions of emotion as motivational incentives: Evidence from a differential implicit learning paradigm. *Emotion*, 5, 41-54.

Schwartz, C. E., Snidman, N., & Kagan, J. (1996). Early temperamental predictors to Stroop interference to threatening information at adolescence. *Journal of Anxiety Disorders*, 10, 89-96.

See, J., MacLeod, C., & Bridle, R. (2009). The reduction of anxiety vulnerability through the modification of attention bias: A real-world study using a home-based cognitive bias modification procedure. *Journal of Abnormal Psychology*, 118(1), 65-75.

Seligman, M. E. P. (1971). Phobias and preparedness. *Behaviour Therapy*, 2, 307-320.

Selman, R. (1980). *The growth of interpersonal understanding*. New York, USA: Academic Press.

Shalev, L., & Algom, D. (2000). Stroop and Garner effects in and out of Posner's beam: Reconciling two conceptions of selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, 26, 997-1017.

Silvia, P. J., Allan, W. E., Beauchamp, D., Maschauer, E., & Workman, J. O. (2006). Biased recognition of happy facial expressions in social anxiety. *Journal of Social and Clinical Psychology*, 25(6), 588-602.

Singleton, N., Bumpstead, R., O'Brien, M., Lee, A. & Meltzer, H. (2001). *Psychiatric morbidity among adults living in private households, 2000*. London, UK: TSO.

Smith, S. D., Most, S. B., Newsome, L. A., & Zald, D. H. (2006). An emotion-induced attentional blink elicited by aversively conditioned stimuli. *Emotion*, 6(3), 523-527.

Spence, S. H., Donovan, C., & Brechman Toussaint, M. (1999). Social skills, social outcomes, and cognitive features of childhood social phobia. *Journal of Abnormal Psychology*, 108(2), 211-221.

Spielberger, C. D. (1972). Conceptual and methodological issues in anxiety research. In C. D. Spielberger (Ed.), *Anxiety: Current trends in theory and research* (pp. 481-492). New York, USA: Academic Press.

Spielberger, C. D. (1973). *Manual for the State-Trait Anxiety Inventory for Children*. Palo Alto, CA: Consulting Psychologists Press.

Srivastava, P., & Srinivasan, N. (2010). Time course of visual attention with emotional faces. *Attention, Perception, & Psychophysics*, 72(2), 369-377.

Staugaard, S. R. (2010). Threatening faces and social anxiety: A literature review. *Clinical Psychology*, 30, 669-690.

Steinmetz, K. M., Muscatell, K. A., & Kensinger, E. A. (2010). The effect of valence on young and older adults' attention in a rapid serial visual presentation task. *Psychology and Aging*, 25(1), 239-245.

Stevens, S., Rist, F., & Gerlach, A. L. (2009). Influence of alcohol on the processing of emotional facial expressions in individuals with social phobia. *British Journal of Clinical Psychology*, 48, 125-140.

Stevens, S., Rist, F., & Gerlach, A. L. (2011). Eye movement assessment in individuals with social phobia: Differential usefulness for varying presentation times? *Journal of Behaviour Therapy and Experimental Psychiatry*, 42, 219-224.

Stevenson, J., Batten, N., & Cherner, M. (1992). Fears and fearfulness in children and adolescents: A genetic analysis of twin data. *Journal of Child Psychology and Psychiatry*, 33, 977-985.

Stirling, L., Eley, T. C., & Clark, D. M. (2006). Avoidance of negative faces and social anxiety in children. *Journal of Clinical Child & Adolescent Psychology*, 35, 440-445.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643-662.

Taghavi, M. R., Dalgleish, T., Moradi, A. R., Neshat-Doost, H. T., & Yule, W. (2003). Selective processing of negative emotional information in children and adolescents with generalised anxiety disorder. *British Journal of Clinical Psychology*, 42, 221-230.

Taghavi, M. R., Neshat-Doost, H. T., Moradi, A. R., Yule, W., & Dalgleish, T. (1999). Biases in visual attention in children and adolescents with clinical anxiety and mixed anxiety-depression. *Journal of Abnormal Child Psychology*, 27(3), 215-223.

Taylor, C. T., Bomyea, J., & Amir, N. (2010). Attentional bias away from positive social information mediates the link between social anxiety and anxiety vulnerability to a social stressor. *Journal of Anxiety Disorders*, 24, 403-408.

Telzer, E. H., Mogg, K., Bradley, B. P., Mai, X., Ernst, M., Pine, D. S., & Monk, C. S. (2008). Relationship between trait anxiety, prefrontal cortex, and attention bias to angry faces in children and adolescents. *Biological Psychology*, 79, 216-222.

Tipples, J., Young, A. W., Quinlan, P., Brooks, P., & Ellis, A. W. (2002). Searching for threat. *Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, 55(3), 1007-1026.

Tomkins, S. S. (1984). Affect theory. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion*. Hillsdale, NJ, USA: Erlbaum.

Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of the ancestral environments. *Ethology and Sociobiology*, 11(4-5), 375-424.

Tooby, J., & Cosmides, L. (2000). Toward mapping the evolved functional organisation of mind and brain. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (2nd ed.). Cambridge, MA, USA: MIT Press.

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., Marcus, D. J., Westerlund, A., Casey, B. J., & Nelson, C. (2009). The NimStim set of facial expressions: Judgements from untrained research participants. *Psychiatry Research*, 168, 242-249.

Trick, L. M., & Enns, J. T. (1998). Lifespan changes in attention: the visual search task. *Cognitive Development*, 13, 369-386.

Trippe, R. H., Hewig, J., Heydel, C., Hecht, H., & Miltner, W. H. R. (2007). Attentional blink to emotional and threatening pictures in spider phobics: Electrophysiology and behaviour. *Brain Research*, 1148, 149-160.

Van Damme, S., Crombez, G., Hermans, D., Koster, E. H. W., & Eccleston, C. (2006). The role of extinction and reinstatement in attentional bias to threat: A conditioning approach. *Behaviour Research and Therapy*, 44, 1555-1563.

Vasey, M. W., Daleiden, E. L., Williams, L. L., & Brown, L. M. (1995). Biased attention in childhood anxiety disorders: A preliminary study. *Journal of Abnormal Child Psychology*, 23(2), 267-279.

Vasey, M. W., El-Hag, N., & Daleiden, E. L. (1996). Anxiety and the processing of emotionally-threatening stimuli: Distinctive patterns of selective attention among high- and low-test-anxious children. *Child Development*, 67, 1173-1185.

Vaquero, J. M. M., Frese, B., Lupianez, J., Megias, J. L., & Acosta, A. (2006). The attentional blink effect: Influence of negative words in an affective valence categorization task. *Psicothema*, 18(3), 525-530.

Veljaca, K., & Rapee, R. M. (1998). Detection of negative and positive audience behaviours by socially anxious subjects. *Behaviour Research and Therapy*, 36(3), 311-321.

Verkuil, B., Brosschot, J. F., Putman, P., & Thayer, J. F. (2009). Interacting effects of worry and anxiety on attentional disengagement from threat. *Behaviour Research and Therapy*, 47, 146-152.

Visser, T. A. W., Boden, C., & Giaschi, D. E. (2004). Children with dyslexia: evidence for visual attention deficits in perception of rapid sequences of objects. *Vision Research*, 44, 2521-2535.

Visu-Petra, L., Tincas, I., Cheie, L., & Benga, O. (2010). Anxiety and visual-spatial updating in young children: An investigation using emotional facial expressions. *Cognition and Emotion*, 24(2), 223-240.

Vrana, S. R., & Gross, D. (2004). Reactions to facial expressions: Effects of social context and speech anxiety on responses to neutral, anger, and joy expressions. *Biological Psychology*, 66, 63-78.

Vrticka, P., Andersson, F., Grandjean, D., Sander, D., & Vuilleumier, P. (2008). Individual attachment style modulates human amygdala and striatum activation during social appraisal. *PLoS ONE*, 3(8), e2868.

Waghorn, G., Chant, D., White, P., & Whiteford, H. (2004). Delineating disability, labour force participation and employment restrictions among persons with psychosis. *Acta Psychiatrica Scandinavica*, 109(4), 279-288.

Wallace, S., & Alden, L. (1997). Social phobia and positive social events: The price of success. *Journal of Abnormal Psychology*, 106, 416-424.

Warren, S. L., Emde, R. N., & Sroufe, L. A. (2000). Internal representations: Predicting anxiety from children's play narratives. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39, 100-107.

Waters A. M., Craske, M. G., Bergman, L., & Treanor, M. (2008). Threat interpretation bias as a vulnerability factor in childhood anxiety disorders. *Behaviour Research and Therapy*, 46, 39-47.

Waters, A. M., Kokkoris, L. L., Mogg, K., Bradley, B. P., & Pine, D. S. (2010). The time course of attentional bias for emotional faces in anxious children. *Cognition and Emotion*, 24(7), 1173-1181.

Waters, A. M., Lipp, O. V., & Spence, S. H. (2004). Attentional bias toward fear-related stimuli: An investigation with nonselected children and adults and children with anxiety disorders. *Journal of Experimental Child Psychology*, 89, 320-337.

Waters A. M., Neumann, D. L., Henry, J., Craske, M. G., & Ornitz, E. M. (2008). Baseline and affective startle modulation by angry and neutral faces in 4-8-year-old anxious and non-anxious children. *Biological Psychology*, 78, 10-19.

Waters, A. M., Pittaway, M., Mogg, K., Bradley, B. P., & Pine, D. S. (2013). Attention training towards positive stimuli in clinically anxious children. *Developmental Cognitive Neuroscience*, 4, 77-84.

Waters, A. M., Wharton, T. A., Zimmer-Gembeck, M. J., & Craske, M. G. (2008). Threat-based cognitive biases in anxious children: Comparison with non-anxious children before and after cognitive behavioural treatment. *Behaviour Research and Therapy*, 46, 358-374.

Weems, C. (2008). Developmental trajectories of childhood anxiety: Identifying continuity and change in anxious emotion. *Developmental Review*, 28, 408-502.

Weems, C. F., & Watts, S. E. (2005). Cognitive models of childhood anxiety. In C. M. Velotis (Ed.), *Anxiety disorder research* (pp. 205-232). Hauppauge, NY, USA: Nova Science.

Wells, A. (2000). *Emotional disorders and metacognition: Innovative cognitive therapy*. Chichester, UK: John Wiley & Sons.

Weichselgartner, E., & Sperling, G. (1987). Dynamics of automatic and controlled visual attention. *Science*, 238, 778-780.

Weis, R. (2008). *Introduction to abnormal child and adolescent psychology*. Thousand Oaks, CA, USA: Sage Publications.

Weiss, B., Weisz, J. R., Politano, M., Carey M., Nelson W. M., & Finch A. J. (1991). Developmental differences in the factor structure of the Children's Depression Inventory. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 3, 38-45.

Wellman, H. M. (1990). *The child's theory of mind*. Cambridge, MA, USA: MIT Press.

Wells, A., & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. Hillsdale, NJ, USA: Lawrence Erlbaum Associates.

White, L. K., Suway, J. G., Pine, D. S., Bar-Haim, Y., & Fox, N. A. (2011). Cascading effects: The influence of attention bias to threat on the interpretation of ambiguous information. *Behaviour Research Therapy*, 49(4), 244-251.

Wilkowski, B. M., & Meier, B. P. (2010). Bring it on: Angry facial expressions potentiate approach-motivated motor behaviour. *Journal of Personality and Social Psychology*, 98(2), 201-210.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin*, 120, 3-24.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive psychology and emotional disorders*. Chichester, UK: Wiley.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders*. London: Wiley.

Wilson, E., & MacLeod, M. (2003). Contrasting two accounts of anxiety-linked attentional bias: Selective attention to varying levels of stimulus threat intensity. *Journal of Abnormal Psychology, 112*, 212-218.

Wilson, E. J., MacLeod, C., Mathews, A., & Rutherford, E. M. (2006). The causal role of interpretive bias in anxiety reactivity. *Journal of Abnormal Psychology, 115*, 103-111.

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition and Emotion, 24*(1), 3-47.

Yiend, J., Mackintosh, B., & Mathews, A. (2005). The enduring consequences of experimentally induced biases in interpretation. *Behaviour Research and Therapy, 43*(6), 779-797.

Yiend, J., & Mathews, A. (2001). Anxiety and attention to threatening pictures. *Quarterly Journal of Experimental Psychology, 54A*, 665-681.

Yoon, K. L., & Zinbarg, R. E. (2007). Threat is in the eye of the beholder: Social anxiety and the interpretation of neutral facial expressions. *Behaviour Research and Therapy, 45*, 839-847.

Appendix A

State Version of the State-Trait Anxiety Inventory for Children (STAI-C).

Full reference: Spielberger, C. D. (1973). *Manual for the State-Trait Anxiety Inventory for Children*. Palo Alto, CA: Consulting Psychologists Press.

[Content removed for copyright reasons]

Trait Version of the State-Trait Anxiety Inventory for Children (STAI-C).

Full reference: Spielberger, C. D. (1973). *Manual for the State-Trait Anxiety Inventory for Children*. Palo Alto, CA: Consulting Psychologists Press.

[Content removed for copyright reasons]

Appendix B

The Short Version of the Children's Depression Inventory (CDI:S)

Full reference: Kovacs, M. (1992). *Children's Depression Inventory Manual*. Los Angeles, USA: Western Psychological Services.

[Content removed for copyright reasons]

Appendix C

Example Covering Letter to Schools

Dear *[headteacher's name]*,

I am a PhD student at the University of Derby, carrying out psychological research into children's visual attention. I am writing to you because I would like to know whether you are interested in allowing some of the children at your school to take part in this project.

One of the objectives of this research is to determine whether children are able to attend to and process consecutively presented visual stimuli at the same rate as adults. I am also interested in the relationship between children's mood and their ability to attend to and process this visual information. I would like to carry out this research with your pupils aged 8 to 11 years and it is hoped that this will be done during May, June and July of this year.

During the experiment, children will be asked if they would like to take part in two computer-based games, both of which will involve watching a stream of rapidly presented pictures. One of the games will require children to identify a basic shape (e.g., a square) from the stream; the other will require them to identify a face (e.g., a happy face). The computer games will run on my own laptop so there will be no need to use any of the school's PCs. The number of correct responses and the time taken to respond will be recorded. In between the computer games, children will be asked some simple questions about their mood and responses will be recorded. These questions will be taken from standard scales that measure for levels of anxiety and depression. Afterwards, children will be thanked for taking part, debriefed, and given a sticker to say thank you and well done. It is estimated that the study will take approximately 25 minutes per child. To ensure that children are able to concentrate on the tasks, I will need to test them individually in a quiet location at the school. Please note that I will be able to provide an Enhanced Criminal Records Bureau Disclosure.

As would be expected, children will have the right to withdraw from participation at any time. Anonymity and confidentiality are assured in accordance with the British Psychological Society requirements and the Data Protection Act (1984).

Please let me know whether it will be possible for me to undertake this study at your school. In return for your help, I would provide the school with £50 in book vouchers and a report of the findings, once the results have been analysed. Thank you for taking the time to consider my request. Should you require further information, please do not hesitate to contact me. I look forward to hearing from you!

Yours Sincerely,

Lauren Kelly.

Example Covering Letter to Parents

Dear Parent/Guardian,

I am currently undertaking a PhD in Psychology at the University of Derby and part of this will involve carrying out a study into children's visual attention. One of the objectives of this research is to determine whether children are able to attend to and process visual information at the same rate as adults. I am also interested in investigating the relationship between children's mood and their ability to attend to and process this information.

I would like to carry out this research with pupils aged 8 to 11 years at *[name of school]* and I have the permission of *[name of headteacher]* to carry out the study. It is estimated that the experiment will take approximately 25 minutes per child.

During the experiment, children will be asked if they would like to take part in two computer games, both of which will involve watching a stream of rapidly presented pictures on a computer screen. One of the games will require the child to identify which shape or shapes they have seen (i.e., a square, a triangle or a circle) in the stream and the other game will require them to select which face of faces they have seen (i.e., a happy face, an angry face or a neutral face). In between the computer games, they will be asked some simple questions about their mood and responses will be recorded. Afterwards, children will be thanked for taking part, debriefed, and given a sticker as a way of saying thank you. Children will be tested individually in a quiet location at the school.

Please understand that children will have the right to withdraw from participation at any time and that anonymity and confidentiality are assured in accordance with the British Psychological Society requirements and the Data Protection Act (1984).

Thank you for taking the time to read over this letter. If you have any questions, please feel free to contact me using the details provided at the top of the letter. If you would like your child to take part in the study, please complete and return the reply slip to the school.

Yours Faithfully,

Lauren Kelly.

Reply Slip

I would like my child, _____
to take part in the study on visual attention.

Signed parent/guardian _____

Example Brief

To be read out to participants:

Hello, my name is Lauren and I am a student at the University of Derby. These activities are about concentration and I would like to find out how well you can spot different pictures. I am also interested in finding out about your mood. All of the activities should take you a total of about 25 minutes to complete.

For two of the activities, you will be asked to take part in a computer game. One of the games will require you to select which shape or shapes you have seen (e.g., a square) and the other game will require you to select which face or faces you have seen (e.g., a happy face). You will be able to practice the games before you take part for real. You will also be given some simple questions to answer during this session. These will ask you about how you usually feel and how you are feeling at the moment. You will be given more detailed instructions during the activities so don't worry.

Please understand that you do not have to take part in these activities if you do not want to and you can stop taking part at any time.

Are you comfortable with everything? Do you have any questions? Feel free to ask me questions throughout the activities.

So, would you like to help me out by taking part in some games and answering some questions?

If yes, ask the child to read the consent form and/or read it out to them. If they are comfortable with everything and would like to take part, ask the child to fill out the consent form. If the child refuses or looks like they are unhappy, do not carry out the experiment with them.

If you are happy with everything and would like to help, please tick the boxes and then write down your name, date of birth and today's date. I would also like you to sign the form by writing your name again.

Participant Assent Form

Participant No.:

Date:

Please tick

each box

1. I have been told about the activity and any questions that I may have asked
have been answered. ☐

2. I understand that I can stop taking part before, during or after the activity
without giving a reason and nobody will mind. ☐

3. I agree to take part in the activity. ☐

First name:

Second name:

Gender:

Age:

Date of birth:

Example Debrief

Thank you very much for your help.

I was interested in looking at how well you could pick out the shapes or faces that were hidden amongst the scrambled pictures and how long it took you to answer. I was also interested in finding out whether children who feel happier are better or worse at spotting the happy faces, and whether children who feel less happy are better or worse at spotting the angry faces.

Do you have any questions? If you have any at a later point or if you don't want me to keep your answers, you should speak to your teacher.

N.B. The teacher will have access to my contact details should they need to speak to me.

Thank you, you've been very good. Please choose a sticker to wear.

Appendix D

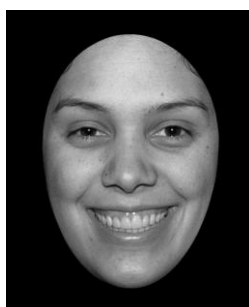
Modified NimStim Face Set used in Investigations Five to Seven

Threatening



03F_AN_O

Positive



03F_HA_O

Neutral



03F_NE_O



09F_AN_O



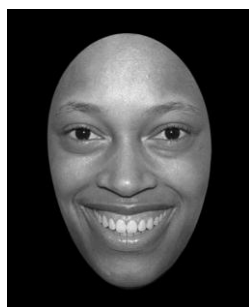
09F_HA_O



09F_NE_O



14F_AN_O



14F_HA_O



14F_NE_O

Threatening

Positive

Neutral



19F_AN_O



19F_HA_O



19F_NE_O



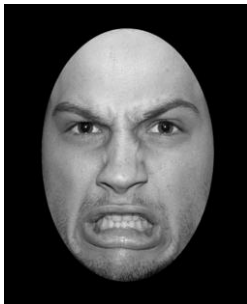
20M_AN_O



20M_HA_O



20M_NE_O



36M_AN_O



36M_HA_O



36M_NE_O



37M_AN_O

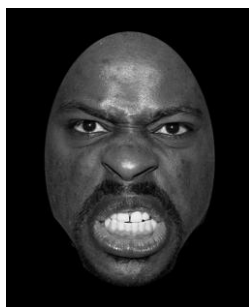


37M_HA_O



37M_NE_O

Threatening



40M_AN_O

Positive



40M_HA_O

Neutral



40M_NE_O

Appendix E

The Attentional Control Scale for Children (ACS-C)

Full reference: Muris, P., de Jong, P. J., & Engelen, S. (2004). Relationships between neuroticism, attentional control, and anxiety disorders symptoms in non-clinical children. *Personality and Individual Differences*, 37, 789-797.

[Content removed for copyright reasons]